universität wien

DIPLOMARBEIT

Titel der Diplomarbeit

„On the Variety of Opinion About What is Uncertain"

Verfasser

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angestrebter akademischer Grad

Magister der Sozial- und Wirtschaftswissenschaften
(Mag.rer.soc.oec.)

Wien, Dezember 2011

Studienkennzahl lt. Studienblatt:	A 140
Studienrichtung lt. Studienblatt:	Diplomstudium Volkwirtschaft
Betreuer	Univ.-Prof. Dr. Erich Streissler

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Ch.1 Introduction

"In this world nothing can be said to be certain, except death and taxes."[1]

"It is interesting that the stability of the system and its sensitiveness to changes in the quantity of money should be so dependent on the existence of a variety of opinion about what is uncertain."[2]

Syllabus

The main goal of this paper is to analyse market volatilities and correlations in the long run. The theoretical part serves as a short excurses into various theories about uncertainty and risk. This is mean to give some insight into the dynamics guiding the markets as well as some psychological underpinning of what we observe in the markets in the real world. The empirical part contains results for a wide variety of assets. The main result of this paper is that market correlations have changed over the past almost four decades with an especially strong increase in correlation over the past decade.

1.1 Introduction

Uncertainty is a fact of life. However, as humans our memories seem to fail us again and again. Looking at just the past two decades or so drives this point home. The first part of the 1990's was a time of prosperity where the public (once more) believed that we have stepped into a new era, one of endless prosperity. We were however rudely upset by the Asian crisis of 1997 and the Russian financial crisis the following year. By the end of 2000 there was again much to cheer about. The Dot Com Boom heralded the coming of a 'new era' and stock valuations and indexes have reached never before seen highs. March 2001 saw the bursting of what in hindsight was one of the most significant bubbles in history and previous stock valuations became absurd almost overnight. Combined with the September 11 attacks and the ensuing geo-political shifts, markets remained bearish till Spring 2003 when the tide turned once more. The 2003-2007 period, with its boom relying on the subprime mortgage market, a market previously mostly untapped by "high finance" financial institutions, saw record corporate profits. As of September 2007 there were clear signs of a developing crash, which sure enough hit home almost exactly one year later. We live in a time of new economic realities, where aside from an accelerated power shift from the West to the East, nothing seems certain.

1.2 Overview

This paper is organized into four chapters. Chapter 2 deals with the preliminaries and the theoretical background. Chapter 3 deals with the first empirical part, consisting of analysis of market volatilities. Chapter 4 builds on the results of chapter 3 and is the most important chapter as it constitutes the core of my research, market correlations in the long run. At the end the conclusions and short remarks on the importance of the findings is presented.

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[1] Benjamin Franklin, in a letter to Jean-Baptiste Leroy, 1789.

[2] (Keynes 1936), p.172

[3] (Keynes 1936), p.172

Obligation. What CDOs do and what role they played in the 2008 crisis is to follow in

Ch. 2 Preliminaries

2.1 What is meant by 'variety of opinion about what is uncertain' and why should we care?

In post-crisis times like these, it seems that the only certainty about the markets is that they are driven by uncertainty. The importance of uncertainty in economic decision-making is trivial. Much has been said about how economic agents cope with uncertainty. This however is not the goal of this paper. What I attempt is to concentrate on what role the variety of opinion about an uncertain future has in actually forming the future, i.e. the trends in the market.

Every trade needs two participants. There are many reasons why anyone would engage in trade. In the case of financial assets however, in many cases it is opposite opinions about the same asset, or more precisely the expected return of that asset, that enables trade. Probably the most prominent example of our time is in relation with the subprime mortgage. This is the case of CDOs[3], a financial vehicle, which is in essence insurance against the negative effects of an increase in defaults of loans. CDOs became especially popular in relation with the subprime mortgage market. Up until spring 2007 AIG FP[4] was a real CDO machine more than happy to take on tens, according to some sources hundreds, of billions of dollars of exposure while its counterparties were more than happy to buy cheap insurance to hedge some of their subprime mortgage market exposures.[5]

The news during the September-October 2008 crash, regarding who did or declared what, is probably fresh in our memories. There was a frenzy of activity, no one knowing what is going to happen, especially how big the losses were going to be. In Chapter 3 we look into the events of those fateful days more in depth.

We don't even have to go back as far as 3 years, however. The here and now are perfect examples of very diverging opinions regarding what is uncertain and what magnitude the uncertainty really is. The complexity of the European debt crisis - what are the biggest dangers, and how one should attempt tackling those problems as well as the existence of different groups of investors, market participants, taxpayers, politicians – virtually guarantees a variety of opinion about what is uncertain.[6]

Before we start however with our empirical part, let us concentrate a bit more on some theoretic background.

2.2 Digging Deeper

2.2.1 Uncertainty

Wherever the future state of the world is not known, we are faced with uncertainty. How we deal with this uncertainty is of paramount importance for the markets.

Uncertainty has been categorized into different groups, all having acquired different meanings and characteristics. Knight in his seminal work from 1921 makes a distinction

[3] Collateralized Debt Obligation. What CDOs do and what role they played in the 2008 crisis is to follow in Ch.3.

[4] The Financial Products arm of American Insurance Group, the now infamous behemoth (although 'black star' is a more apt epithet).

[5] Story of AIG FP has been told in great detail among others in (Lewis 2010).

[6] And bestowes finding a suitable solution with paramount difficulty.

between uncertainty, which is immeasurable, and risk, which is measurable. In his words:

"Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated.... The essential fact is that 'risk' means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomena depending on which of the two is really present and operating.... It will appear that a measurable uncertainty, or 'risk' proper, as we shall use the term, is so far different from an unmeasurable one that it is not in effect an uncertainty at all."[7]

The Knightian distinction has found acceptance. A related point is that of the Ellsberg Paradox. This one combines the two types of risk. Let us consider an urn that contains *n* number of red balls and *y* number of either all blue or black balls. This way upon drawing one ball we are faced both with uncertainty, we do not know if the urn contains blue or black balls and also a probability risk, whether the ball is red or non-red.
A related concept is that of predictable and unpredictable variation. The debate relating to this has been known as the common-cause special-cause debate.

One of the newest proposals in the theory of probability and uncertainty comes from Taleb in what he calls the Black Swan theory. He makes no distinctions between different types of uncertainty. The Black Swan Theory pertains to seldom and unforeseen but high impact events that, in retrospect, are rationalized. In the author's own words:

"What we call here a Black Swan (and capitalize it) is an event with the following three attributes. First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable.
I stop and summarize the triplet: rarity, extreme impact, and retrospective (though not prospective) predictability. A small number of Black Swans explains almost everything in our world, from the success of ideas and religions, to the dynamics of historical events, to elements of our own personal lives."[8]

Examples of Black Swan events would be the invention of the personal computer, the rise of the Internet, World War I, September 11 attacks, etc. Taleb also takes a very critical view of the Knightian differentiation of different types of uncertainty.[9] Taleb's work has unleashed much criticism, as it seems apparently to be founded on wrong estimations, in a historically unusual period[10]. He further assumes that there are no

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[7] (Knight 1921)
[8] (Taleb 2008) Prologue p.1.
[9] "In real life you do not know the odds; you need to discover them, and the sources of uncertainty are not defined. Economists, who do not consider what was found by non-economists worthwhile, draw an artificial distinction between Knightian risk (which you can compute) and Knightian uncertainty (which you cannot compute), after one Frank Knight, who rediscovered the notion of unknown uncertainty and did a lot of thinking but perhaps never took risks, or perhaps lived in the vicinity of a casino. Had he taken financial or economic risk he would have realized that these "computable" risks are largely absent from real life! They are laboratory contraptions." (Taleb 2008), p40.
[10] The book appeared in 2008 just as the financial crisis was feveloping.

approximately correct procedures and has a very dim view of professional risk estimation.

Returning to the Knightian differentiation of risk and uncertainty. According to this differentiation, if not all future states of the world are known, we are in the realm of uncertainty. If however, we were able to think of *all* conceivable states of the future, then based on data it should be able to assign probabilities, may those be objective or subjective, so that the sum of these probabilities would be one.
Since in real life we are unable to capture all possible future states of the world, simplifications are necessary. The most rudimentary of them all would be to consider only two possible states of the world.[11] An entire risk estimation industry has evolved and financial institutions and insurance companies have developed vast models based on extensive data. As long as the underlying probability system does not change, as it would in the case of Black Swan events, these models are able to make appropriate predictions. The latest financial and following economic crisis[12] however underlined the fact that even these sophisticated models can fail and fail miserably.This is due to the fact that many times they are far too limited in that they do not allow, or are incapable of, incorporating the ever-changing economic reality we live in. Over-optimism, along with other system-inherent flaws, have also contributed to the miserable failure that the rating agencies, the gatekeepers of modern high finance, have suffered.

2.2.2 Variety of Opinion

Assumptions that lay at the basis of every economic model are. The dominant economic framework of our day is that of neoclassical economics. Some of the main assumptions are with regards to the *homo oeconomicus*, the 'economic man'. A rational, self-interested individual with tremendous capacity to analyze all available information, (always) capable of making decisions in accordance with his/her rational preferences. This creature has a counterpart in the economy in the form of a firm and the firm's only purpose is to maximize its profits.
The base problem is that model simplistic enough to work with, by the very nature of the simplifications, will inadvertently carry the possibility of making erroneous predictions or explanations.
The last important simplifying assumption of neoclassical economics is with regards to available information. It assumes that information is readily and costlessly available. In such a 'perfect' world there would be no variety of opinion about what the best, rational, utility maximizing decisions were. The only difference between economic agents would stem from variety in their preferences. This however would not affect the way they analyze information and act accordingly.
Truth is, real world abounds with sources of imperfections in the decision-making of individuals and by extension the functioning of the markets. Economic agents are subject to 'bounded rationality'[13]. Other incorporated ideas into some of the new economic theories, chiefly behavioral economics include cognitive and information biases, etc. These addendums help in explaining among other things irrational exuberance and herd behavior, both of which play a significant role in the study of financial markets. These departures from a perfect economic state, as mentioned earlier, have repercussions regarding the functioning of the markets.

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[11] e.g.: positive economic growth with probability 0.8; no or negative growth with probability 0.2
[12] (Reinhart and Rogoff, From Financial Crash to Debt Crisis 2011) gives a long-term view of the relationship between financial crashes and debt crises
[13] A term coined by Herbert Simon and it includes departures from 'perfect' economic conditions on the basis of informational and cognitive limitations as well as limited time to make certain decisions.

2.3 Thought Experiments

Let us take part in two simple thought experiments in order to explore various aspects of the nature of the uncertainty.

First consider a bull market that has been a bull market for a couple of years. Knowing that in the past bull markets have always been followed by temporary setbacks, most of the market participants expect a trend reversal in the near future. The uncertainty is, among other things but chiefly, timing. No one knows with certainty when that reversal might come. However investors would like to stay in the market right up until its apogee and sell their assets before the values drop.

A plausibly derived, but as of yet unproven suggestion is that market volatility around the mean, which is also the time of reversal, is related to the size of variance of opinion. The volatility in the market in case of the high variance in opinion should be ceteris paribus lower than in a low variance environment. How concentrated opinions around the mean are will affect the strength of the trend reversal and by extension volatility.
There is also, of course, the question of the amount of funds in the market and what the distribution of these funds is in relation to the distribution of opinions about the timing of the reversal. Or in simplest terms: who is of what opinion and what is the amount of funds the investor controls. Thus, more correctly, it is the distribution of opinion *and* the amount of funds around the mean that will define the magnitude of volatility. Building a model incorporating these two factors, using the normal distribution with fat tails or non-normal distributions, in order to predict or explain market movements, is a great research topic.[14]

Logically, the market volatility around the time of reversal is inversely related with the size of variance of opinion. The volatility in the market in the case of the high-variance in opinions will be lower than in the case of low-variance in opinions. How concentrated opinions around the mean are will in effect define the strength of the trend reversal and thereby the measure of volatility.[15]

In the second thought experiment let us look at a different model that works within a different framowork. Here the emphasis is laid on what happens to the variance in opinion over the different stages of a business cycle.[16] This model, also plausibly derived but as of yet unproven, needs to be multi-period. Our previous thought experiment was constrained by the fact that we implicitly assumed non-dynamic opinions. In real life however, market participants adjust their opinions constantly.[17]
It seems reasonable to assume that the variance in opinion over the different stages of a business cycle would change in the manner described in the following.
Let us start in the core of the boom phase, thus not close to the beginning or the end of the phase. This is where we would expect the least uncertainty. As we approach the end

[14] Data on trade volumes is available for many markets. However, measuring opinions is much harder. Data ontrade volumes for opaque markets like many over-the-counter derivatives is hard to come by.
[15] A high-variance in opinion scenario would mean less market participants surrounding the immediate vicinity of the mean (than in the low-variance scenario). Therefore it is logical that the strength of the reversal will be lower in the high-variance environment as there will probably be either fewer trades or lower volume or both, all of which will have a diminished effect on the change in price.
[16] So far we have been unable (or unwilling) to put an end to business cycles.
[17] Especially in relation with business cycles one theory is worthy of mention. Feedback loops have been mentioned by (Shiller 2000) and extensively advertised as the superior theory to explain business cycles in (Soros 2008).

of the boom and conjecture along with future prospects worsens, there is a shift in opinion regarding the future of the market. So far there had been a generally accepted opinion about the direction the markets would take. Now however, we witness a gradual increase in the variance of opinions regarding that direction. The bears start gaining ground in the market and a tug-of-war ensues between them and those who hold on to the notion of increasing market, the bulls. As the strength of the bears strengthens, market volatility increases and reaches its apogee at the top where finally the bears take over and the decrease in prices starts. In most of these cases those who were long on the market abandond their positions making the drop usually significantly faster than the rise.[18] In the bust phase opinions align once more, expectation of a falling market becomes norm, until the bottom is reached. There once more opinions start to diverge. The tug-of-war between bears and bulls starts anew.[19]
What the data tells us is that when plateaus are reached, may those be supports or ceilings, or in other words peaks or troughs, volatility is higher. This is where the tug-of-war usually involves greater amounts of capital which magnifies volatility. When there exists much debate over the start of the recovery or the end of a boom, volatility is higher.
I have empirically found that therefore variances have twice the number of ups and downs than prices. As we will see later in the analysis, the empirics seem to support this. There are naturally exceptions. In case of a double-dip recession or if there is a second or third round of shocks that influences the market, through postponing the resumption of growth or other ways. It must be mentioned that in the past the volatility at the bottom has been smaller than at the peak. Possible explanation is that investors have memories and it is common knowledge that cycles occur. Thus, when it has been perceived that there had been a boom phase and this phase is nearing its end, it makes more sense to sell the assets near the peak, wait until the boom starts anew and invest again, than to stay in the market during the bust phase.

2.4 Motivation of the Empirical

By now the reader has surely noticed that I used the terms variance in opinion, uncertainty and market volatility in close connection. This serves as the basis of this paper.
It is my belief that the variety of opinion with regards to what is uncertain is a major, if not the most important source of uncertainty, and by extension, volatility in the markets. Therefore, I will use market volatility as a proxy for variety in opinion. In chapter 3 I present results of calculations of market volatilities over a wide variety of asset classes and attempt to find explanation for periods of high volatility. As well, I will attempt to find indications whether market volatilities have changed over time and if so attempt to explain why. By looking at correlations between prices and their volatilities I will attempt to gauge whether correlation of markets has changed over time or not in Chapter 4.

[18] Market psychology has in the meantime developed into an area all of ist own in (financial) economics. Questions such as why people's reaction to decreasing prices triggers sell-offs of the magnitude that we usually witness in a market of falling prices is still unclear.
[19] When the bottom is reached and why there comes a recovery is beyond the scope of this little thought experiment.

Ch3.
ANALYSIS OF VARIANCES

3.1 Introduction

In the following we will be analyzing volatilities of different types of assets.
Our focus will be on instances of increased volatility. We will try to analyze these instances and search for cases where the reason behind increased volatility is speculation. It is in these instances that opinions about uncertainty vary more than is the norm. Speculators' activities magnify the strength of price reversals.
Times of higher uncerainty are by their very nature times of increased volatility. It is uncertainty that moves the market more than anything else.

The selection of assets reflects my desire to get a most comprehensive view on interconnectedness of markets. The three large groups under consideration are stock indexes, commodities and food commodities as well as exchange rates.

Stock indices:

DJI[20] (Dow Jones Industrial) index of the New York Stock Exchange, the largest stock market capitalization in the world;

FTSE 100[21] of the London Stock Exchange; Stock index of the 100 most highly capitalized UK companies listed on the London Stock exchange;

Nikkei 225[22] of the Tokyo Stock Exchange;

DAX[23] (Deutscher Aktien IndeX) of the Frankfurt Stock Exchange; consists of the 30 major German companies trading on the FSE.

Commodities[24] are the following:

Gold[25]: ounce, London pm fix;

Crude Oil: Dated Brent, light blend 38 API, fob U.K., US$ per barrel;

Copper: grade A cathode, LME spot price, CIF European ports, US$ per metric tonne;

Coal: Australian thermal coal, 12,000- btu/pound, less than 1% sulfur, 14% ash, FOB Newcastle/Port Kembla, US$ per metric tonne;

Aluminum: 99.5% minimum purity, LME spot price, CIF UK ports, US$ per metric tonne.

[20] (Yahoo! Finance DJI 2011)
[21] (Yahoo! Finance FTSE 2011)
[22] (Yahoo! Finance N225 2011)
[23] (Yahoo! Finance DAX 2011)
[24] (International Monetary Fund 2011)
[25] (World Gold Council 2011)

Food Commodities[26] are the following:

Wheat: No.1 Hard Red Winter, ordinary protein, FOB Gulf of Mexico, US$ per metric tonne;

Corn: U.S. No.2 Yellow, FOB Gulf of Mexico, U.S. price, US$ per metric tonne;

Rice: 5 percent broken milled white rice, Thailand nominal price quote, US$ per metric tonne;

Sugar: Free Market, Coffee Sugar and Cocoa Exchange (CSCE) contract no.11 nearest future position, US cents per pound.

Exchange rates[27]:

USDEUR[28];

USDGBP;

USDCHF.

I have chosen to use the US Dollar as the base currency because even though it is almost certain that in the long term this currency will lose its dominance, in the past and at present it still retains that position. The Euro as the newest currency still has to prove that it can withstand the stress that crises similar to the current sovereign debt one pose. If it passes this crisis, which is by far the worst in the history of this currency, it will retain much more 'respect' so to speak among the major currencies and will probably be able to snatch some of that aforementioned dominance from the dollar. The Swiss Franc has proven it's value over the past decades and it is showing increased importance especially in a period where both the Euro and the US Dollar have shown a less than stellar performance as owed to the economic crisis and the political debacle that is currently taking center stage on both sides of the North Atlantic. In the meantime, owed to these troubles elsewhere and the comparatively good performance domestically, the CHF's value has increased greatly over the past 3-4 years. Several analysts expect the CHF to reach parity with the Euro in the near future if the EU is unable to find a proper solution to the sovereign debt crisis.[29]
The Japanese Yen is willingly omitted. Many have tried to explain movements in the value of the Japanese Yen, to no avail. Thus as a starting economist, I did not dare venture into such dangerous territory.

[26] Same dataset as footnote #1
[27] (Bank of England 2011)
[28] Data prior to Euro calculated from basket of currencies with same weights as they had in the Euro
[29] The revaluation of the CHF relative to the EUR has reached such proportions that the Swiss central bank decided on pegging the CHF to the EUR and not allowing the CHFEUR exchange rate do dip below 1.2.

3.2 The Data

3.2.1 The Time Factor

It was my intention to look at evolution of prices and values over a long period of time. Chosen starting point is March 1973. It was arguably then that the gold standard finally broke down. From there on the currencies of the developed countries have mostly been free floating. Sadly, data for many assets was unavailable from that early point in time. With the exception of the DAX - which only exists since Nov 26 1990 - data was available for all other indexes all the way back to March 1973. I was only able to find data on commodities from 1980 onwards via the International Monetary Fund website. Gold data is available in some shape or form all the way back to the end of the 19th century, thus this is the fourth and alst asset for which data is available starting March 1973.

3.2.2 Frequency of Data

For all assets monthly data were available. For indexes and gold I was able to find weekly data as well[30]. For these I have used both datasets in my analysis. In most cases these two datasets paint a vers similar picture, however as it will become apparent later, this is not always the case. When treating sudden and sever stock market crashes, at times daily data will also be used to emphasize the tremedous market volatility during those periods.

I have chosen to calculate quarterly volatilities so that comparison with GDP data would be possible. This has not been done in this paper but my results could be used to pursue such research.

In order to make comparison between variances of different assets meaningful, I have 'normalized' the data. First step was calculating quarterly averages. Second, I divided every value by its corresponding quarterly average thus giving percentage deviations from the quarterly mean. The calculated variances are, thus, comparable.

It is a well known fact that, in the past decades limitations to international capital movement have gradually been reduced. In our day capital moves more freely and in larger quantities than ever before. These capital flows are always on the chase for largest possible gains. Moreover, over the past couple of decades, world savings have increased. Many developing economies have a higher savings rate than the developed economies. Those savings, as mentioned earlier are in search of the highest return. The paradoxical, where capital instead of flowing from developed to developing countries actually reverses direction, has happened multiple times in our age. The US boom market in the 90's and part of the years 2000 have been such an event. At any rate, the freedom of capital movement combined with the sheer size of these flows created some of the most interesting price changes. The effects of this new economic reality will become very apparent in Chapter 4 where I analyse market correlations.

[30] For N225 and FTSE only starting March 1984.

3.3 Stock Indexes

3.3.1 The DJI

We start with the Dow Jones Industrial index. The following graphs show the index evolution and quarterly volatilities using monthly and weekly data respectively in the time period March 1973 to March 2011.

Chart 3.3.1.1: DJI evolution 1973-2011, Horizontal axis denotes the corresponding closing price of last day of March of the year

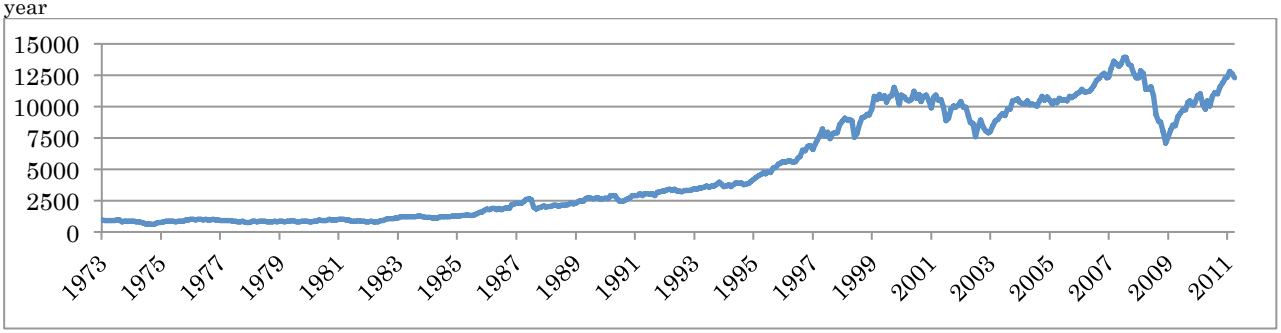


Chart 3.3.1.2: DJI quarterly volatilities 1973-2011 using monthly data

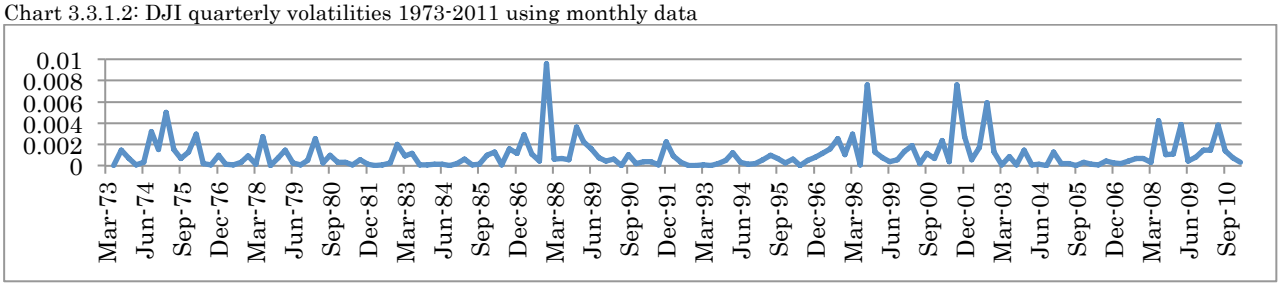
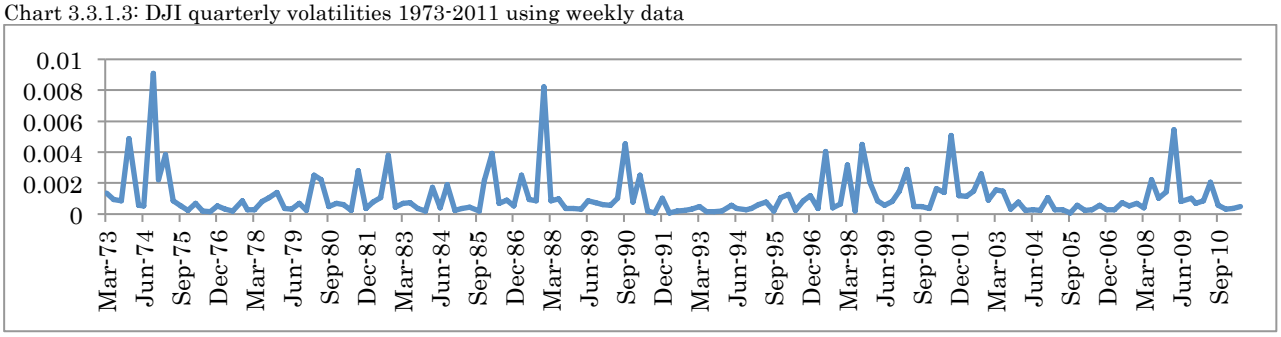


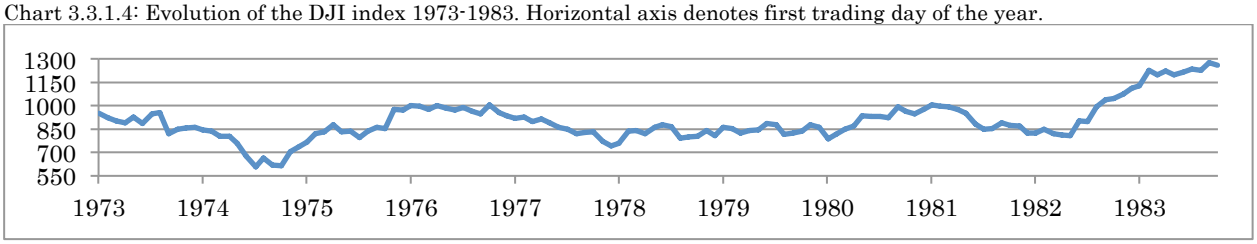
Chart 3.3.1.3: DJI quarterly volatilities 1973-2011 using weekly data



Looking at the evolution of the DJI index we can distinguish two periods with seemingly different characteristics. The first one is roughly the decade 1973 to 1983. It is this decade where between March 1973 and roughly October 1982, the DJI did not attain a considerable increase in value. As for the long-run evolution of the Dow, barred from one very significant drop in value in 1987, the trend is very clearly an upward one till the end of 1999. First let us concentrate on the decade 1973-1983.

3.3.1.1 1973-1983

Chart 3.3.1.4: Evolution of the DJI index 1973-1983. Horizontal axis denotes first trading day of the year.



The two major spikes in volatility in 1973 and 1974 coincide with the political and economic turmoil surrounding the oil crisis. As soon as international agreements and cooperation was established at the end of 1974, volatility decreased, oil prices dropped and this lead to a calming of markets and a strong increase in prices through Jan 1976. From this moment on, there is calmness on the markets. The value of the DJI however moved from roughly 1000 to a low of 769.92 in Jan 78 only to rebound to close to 1000. This is an interesting feature, as we have a very significant price drop and then rebound, but in this case in a very orderly fashion, with low market volatility. The level of volatility is surprisingly low. One could argue that after two major oils shocks within 4 years, prices would have remained more volatile than they actually did. Both monthly and weekly data tell the same story for this period.

At the end of 1979 and 1980 the culprit of higher volatility is again an oil shock, although this time milder, caused by the events in Iran surrounding the flight of the Shah and the installment of the new Ayatollah regime and the beginning of the Iran-Iraq war. A factor that greatly decreased the effect of this oil shock in the USA was the deregulation of the domestic market, which greatly increased production in Alaska. This had a strong equalizing effect in an atmosphere of sharply falling imports.

At the beginning of the 80's, stagflation was the norm for the US economy. The 70's were characterized by rising inflation and unemployment. By 1980 the inflation rate soared to 13.5% from a 3.2% average in the post-war period. Unemployment reached 6.9% and 7.5%in April and May 1980[31]. There was a mild recession in the first half of 1980. Recovery was relatively slow. Reagan took office in January 1981, his different economic philosophy coupled with the new Federal Reserve Chairman, Paul Volcker's commitment to decrease the inflation rate by tightening money supply and increasing the interest rate (the prime interest rate reached a high of 21.5% p.a. in June 1982) introduced some uncertainty into the market. At first much of this uncertainty was as to whether the Fed would be able to stick to its promise. As soon as this commitment has been proven, new policy became credible and the Keynesian economic measures introduced by Reagan as a response to the sluggish recovery started to take effect and recovery sped up. On 3 November 1982, the DJI surged 43.41 points, or 4.25%, to close at 1,065.49. It was the first time in 9 years, on 11 January 1973 to be exact that the DJI stood at roughly the same level, when it reached 1,051.70 points. This was the biggest point gain in history up to that day.
These economic-political facts explain the spikes in volatilities in these two years. When making the comparison between results using monthly and weekly data, we see that the volatilities are much smaller when using monthly data. This leads us to speculate that there was indeed higher volatility in these times as the weekly data gives us more

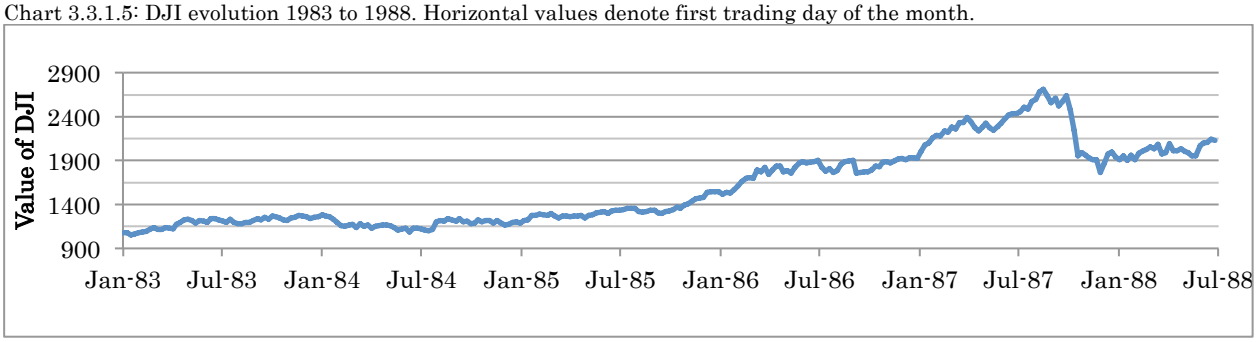
[31] Now (end of 2011) the unemployment rate in the US is hovering around the 9% mark. Many have given up looking for a job and are not contained in this percentage anymore.

precise results but in a long-run (or longer run) context these increases were nevertheless not exceedingly large.

3.3.1.2 Black Monday, 19 October 1987

The next great spike is the one concerning the infamous 19 October 1987 crash, also referred to as 'Black Monday'. This crash has been heavily debated and studied but very many questions still remain as to what exactly transpired on that day.

Chart 3.3.1.5: DJI evolution 1983 to 1988. Horizontal values denote first trading day of the month.

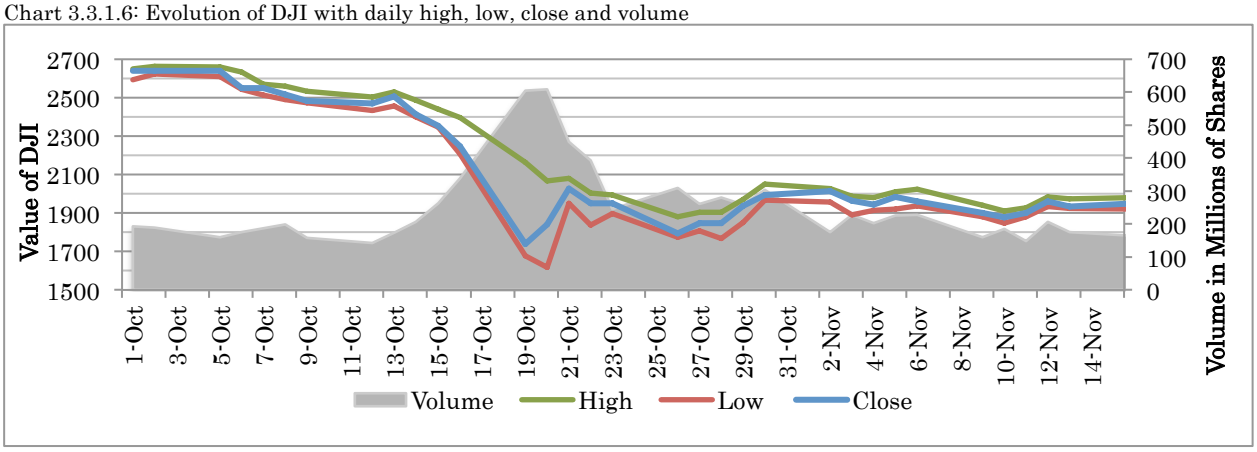


As mentioned earlier from the end of 1982 onwards, there was a strong bullish market up until August 1987. The only spike in volatility is between October 1985 and June 86. In the blow up graph of this period we see that this time was one of especially strong growth. The DJI rose from 1328.74 points on 30 September 1985 to 1900.87 points on 30 June 1986. That is an increase of roughly 43% in 9 months. As we've seen so far, most occasions of increased volatility are coupled with price drops but times of strongly bullish markets are also inherently more volatile. The period February to September 1986 practically left the value of DJI unchanged only to be followed again by very strong growth between July 1986 and August 1987. The increase was from 1763.64 points on 1 Aug to a high of 2722.42 on 25 Aug 1987 or a 54.4% increase in a year, making the combined increase between August 1985 and August 1987 a whopping 104%.
August through October the outlook on the stock market soured.

Wednesday 14 Oct witnessed a 3.8% drop, Thursday 15 Oct 2.38%, Friday 16 Oct 4.6% making for a combined drop of more than 10% for the week.
Then came the fateful day of 19 Oct. Markets in the Far East were quite jittery. The Nikkei lost 2.4%, the Hang Seng index of the Hong Kong Stock Exchange dropped 11.11%. The London Stock Exchange remained closed the previous Friday due to The Great Storm of 1987 and the whole country was still paralyzed on Monday the 19th. This combined with the bad news from the Far East led to a very bad start for the FTSE 100. Towards the end of trading on the London Stock Exchange news of a strong negative start from New York arrived causing further fall. Thus the FTSE 100 dropped 10.84% further precipitating the bad mood on New York[32]. In the early hours of the same day Iranian-US tensions escalated after the shelling of an Iranian oil platform by the US Navy in the Persian Gulf. At the end of the day the Dow Jones dropped 22.61%, by far the largest percentage drop ever on the New York Stock Exchange. At one time during trading that day the index was down 25.3%. Volume on that day was about 3 times larger than the sessions a mere week before and about twice as large as the previous Friday.

[32] This is a prime example of news in one market almost instantly affecting other markets which then in turn affect the market where the original news came from.

Chart 3.3.1.6: Evolution of DJI with daily high, low, close and volume



Volume remained exceedingly high the next day and gradually returned to pre-crash values over the next month. 20 Oct brought an increase of 5.88%, 21 Oct an increase of 10.15%. After these two days of strong recovery the Dow was still about 10% below its closing value the previous Friday. It took the DJI close to a year and a half to recover to the pre-crash region of 2300-2600 points. Interestingly enough, this Black Monday brought a drop almost exactly equal to the other 'Black Monday' and 'Black Tuesday' of 1929 combined. The main difference however was the immediate, strong recovery. Another interesting aspect is that it seems that Black Monday of 1987 affected the US, the country where it originated, the least. Others suffered more serious losses over more extended periods of time. Many attribute this quick rebound to what has later become to be known as the 'Greenspan put', which is an active participation of the central bank to ease liquidity constraints in case of negative shocks to the market.

To this day, there is no universally accepted explanation to what exactly happened that day. Many different factors have been blamed for the crash without any one standing out as the major culprit.

Robert Shiller, in his well-known book *Irrational Exuberance*[33] gives a very interesting analysis of the role news played during the crash. He conducted a survey the very same year in which he included ten news stories published a few days prior to and on the morning of the crash and asked that respondents assign values between 1 and 7 to the importance of that news with 7 indicating high importance and 1 indicating completely unimportant with the option of respondents adding whatever news they considered important. With the exception of one news story, all merited at least a 3 and most a 4. Interestingly, the news story deemed most important was that of price decline of the very same day, which received a rating of 6.54 among individual sellers, 6.05 among institutional sellers on 19 Oct. Second most important was a news story on price declines of the previous week. The most popular answer to the open-ended question "Can you remember any specific theory you had about the causes for the price declines of 14-19 October 1987?" was that the market had been overpriced. 32.6% of private and 33.9% of the institutional investors shared this opinion. Elsewhere on the questionnaire it was asked whether market participants thought that the market was overpriced and 71.7% of the individual (91% of those who indeed sold on that day) and 84.3% of the institutional (88.5% of those who sold on that day) responded affirmatively. Another mentioned theme for causes of the crash was as being institutional selling, program trading, stop-loss or computer trading, which were mentioned by 22.8% of the individual

[33] (Shiller 2000), p.88-95

and 33.1% of the institutional respondents. 'Irrationality of participants' was mentioned by 25.4% of the individual and 24.4% of the institutional investors. Immediately after the open-ended question the following was asked: "Which of the following better describes your theory about the declines: a theory about investor psychology (or) a theory about fundamentals such as profits or interest rates?" 67.5% of the institutional and 64% of the individual investors picked a theory about investor psychology. Thus, it seems that according to participants themselves the crash was due to a psychological feedback loop among the general investing public.
Shiller goes on to mention the results of the Brady Commission, which was set up by President Reagan to study the 1987 crash, which I quote[34]

> The precipitous market decline of mid-October was "triggered" by specific events: an unexpectedly high merchandise trade deficit which pushed interest rates to new high levels, and proposed tax legislation which led to the collapse of the stocks of a number of takeover candidates. This initial decline ignited mechanical, price-insensitive selling by a number of institutions employing portfolio insurance strategies and a small number of mutual fund groups reacting to redemptions. The selling by these investors, and the prospect of further selling by them, encouraged a number of aggressive trading-oriented institutions to sell in anticipation of further market declines. These institutions included, in addition to hedge funds, a small number of pension and endowment funds, money management firms and investment banking houses. This selling, in turn, stimulated further reactive selling by portfolio insurers and mutual funds."

That is to say, the commission's results also point to a feedback mechanism, albeit not one on psychological basis alone, but one that contains automated elements. Shiller goes on to argue that these automated sell-offs are in turn based on institutional investors' attitudes, after all these trading programs work in accordance with preset guidelines, which are in turn results of some psychological stance towards losses. Interestingly enough, none of the 605 individual responses under the category "other" mentioned the proposed tax legislation contained in the Brady Commission's summary.[35]
Another interesting point that Shiller makes about the role of portfolio insurance/program /computer trading is that it is quite reasonable to assume that these new technologies, that have made their way into the industry just a few years prior to the crash, have indeed changed the nature of the feedback mechanism. It has changed the response, both in time and magnitude, of the investors to price declines.
An interesting piece of news however that appeared on the morning of 19 Oct was in the Wall Street Journal. It contained side-by-side graphs of the evolution of the DJI prior to the 1929 crash and that of the evolution of the market for the past couple of years. The picture seemed to imply that there was an imminent crash or significant drop in the making. This is especially interesting considering that the drop on 19 Oct was of the same magnitude as the Black Monday and Tuesday in Oct 1929. However, all of this could be just simply coincidence. Even if so, it would be a most peculiar one.

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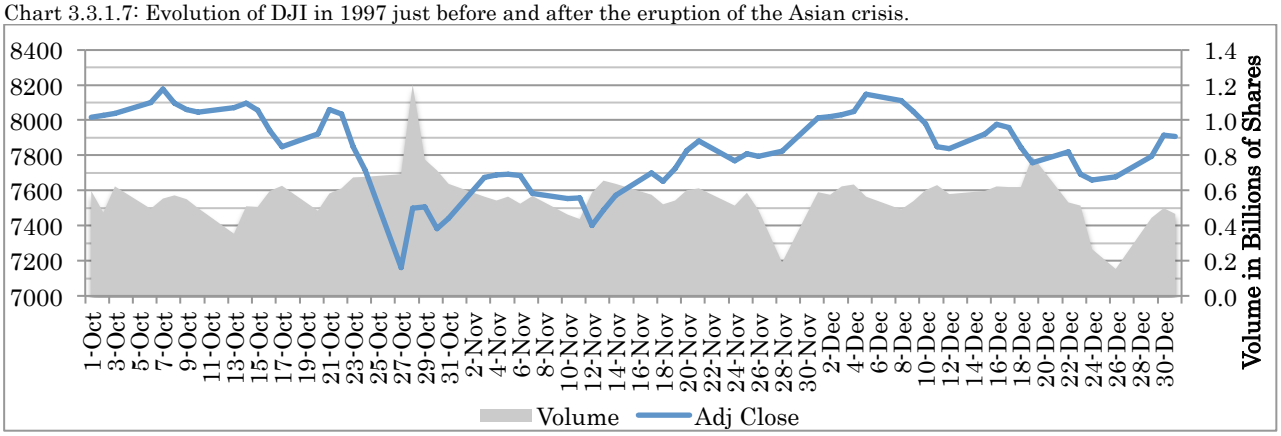
[34] (Presidential Task Force on Market Mechanisms 1988)
[35] While I have no data on what kind of investors Mr. Shiller probed on the events of that day, it is highly likely that they worked for insitutional investors trading mostly in blue chips. The large stocks are of near monopolists, or at least market participants with significant market power, have strong capacity to shift taxes. Empirical evidene seems to validate this by showing that long-term profits of large companies vary little with changes in tax law. Average entrepreneurs (i.e. small firms) may feel changes in tax law more.

Next noteworthy spike in volatility can be attributed to the oil shock created by the first Gulf war. This one was however a short and quite mild spike as the conflict resolved in a short period of time.

3.3.1.3 The 1997 Asian and 1998 Russian Crisis

Next considerable spike, more pronounced with monthly data but perfectly supported by weekly data as well is in 1997-1998. This increase in volatility can be explained by the 1997 Asian financial crisis followed in 1998 by the Russian sovereign debt default.

Chart 3.3.1.7: Evolution of DJI in 1997 just before and after the eruption of the Asian crisis.



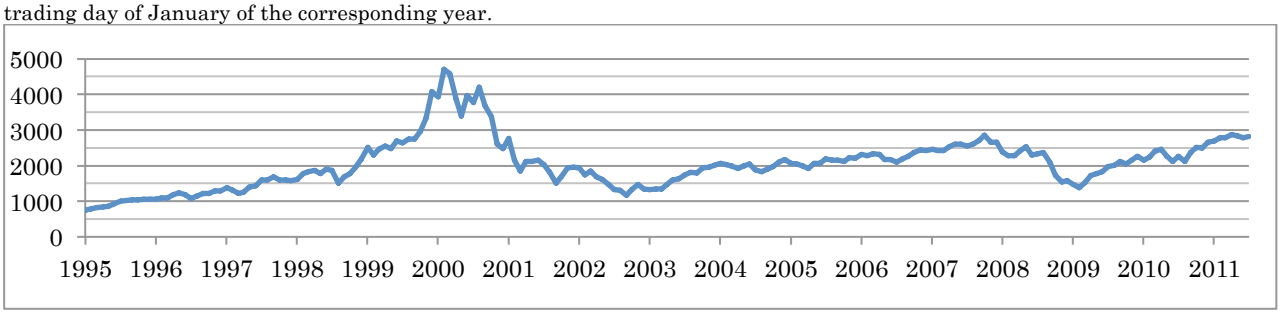
Financial contagion could not be contained and so it spread with dizzying speed to the US market also. On Monday, 27 Oct1997, the Dow Jones Industrial plunged 554 points or 7.18%.This is to this day the 4th largest point drop in the history of the NYSE, only surpassed by Black Monday and three other dates in 2008-2009. This is a total, very unenviable, drop of 11.15% compared to the previous Tuesday. By 1 Dec however, the Dow was above 8,000 points once more.
One could argue that the situation in Asia affected the US financial markets more indirectly than it did directly. It was the crisis in Asia that led to the collapse of the Long Term Capital Management hedge fund, which had enormous exposure to the Asian markets, betting the wrong way.
Ninety eight percent of the LTCM's shareholder equity was wiped out in a Federal Reserve orchestrated takeover. Due to the interconnectedness of LTCM into the financial markets, LTCM's potential demise put great pressure on the markets as a whole and thus something had to be done. An offer was made on 23 Sept by Goldman Sachs, AIG and Berkshire Hathaway to buy out the partners for $250mln and to inject $3.75bln and operate the hedge fund as one of Goldman's divisions. The value of LTCM at the beginning of the year was close to $5bln. No deal has been reached. The Federal Reserve stepped in, however a bailout using government was not offered as an option. Thus a bailout involving private capital was organized at a value of $3.625bln and major creditors including practically all of the major players on Wall Street. A system-wide collapse was averted. The long-term impact of the Fed stepping has great influence during and on the unfolding of the 2007-2008 crisis.

3.3.1.4 The Dot Com Bubble

The Dot-com boom and bust shows up nicely in the volatilities chart with both the monthly and weekly data showing higher volatility around August-September 2001 and then again increased volatility about a year later. The NASDAQ index (which is very concentrated on technology firms' stocks) peaked on 10 Mar 2001 at 5048.62 (with intra-

day peak 5132.52). A look at the NASDAQ evolution sums up the Dot Com Bubble in one graph. A tenfold increase in the index value within a decade is very much indicative of a bubble.

Chart 3.3.1.8: NASDAQ evolution Jan 2 1995 to July 21 2011, end of month closing prices. Horizontal axis denotes first trading day of January of the corresponding year.



In the period between roughly 1997 to early 2001, with the IT sector leading the economic expansion at breakneck speed, there was much talk of the advent of a 'new economy' that would bring an economic revolution comparable to that of the Industrial Revolution.[36] There was unanimous agreement regarding the future of the technology industry. The IT sector would go only one way: up.[37] Editorialist James Glassman and economist Kevin Hassett in 1999 predicted that the Dow would continue its meteoric rise for years to come.[38]

It was typical for technology companies' and Internet upstarts' stock prices to be completely out-of-touch with their fundamentals. If there ever was a time that was dominated by 'irrational exuberance'[39], then this was it. In many cases the aforementioned companies' stocks lost nearly all their value and the majority went bankrupt. Some of the now established technology giants never quite regained the same stock prices that they did during the bubble.[40]

The bursting of the bubble sent shockwaves through the entire economy. Losses were in the trillions.[41] In early 2001, just as president Bush Jr. took office the economy slid into a recession. Uncertainty regarding the USA's response to the Sept 11 attacks and its effects on the economy further fueled the fire.

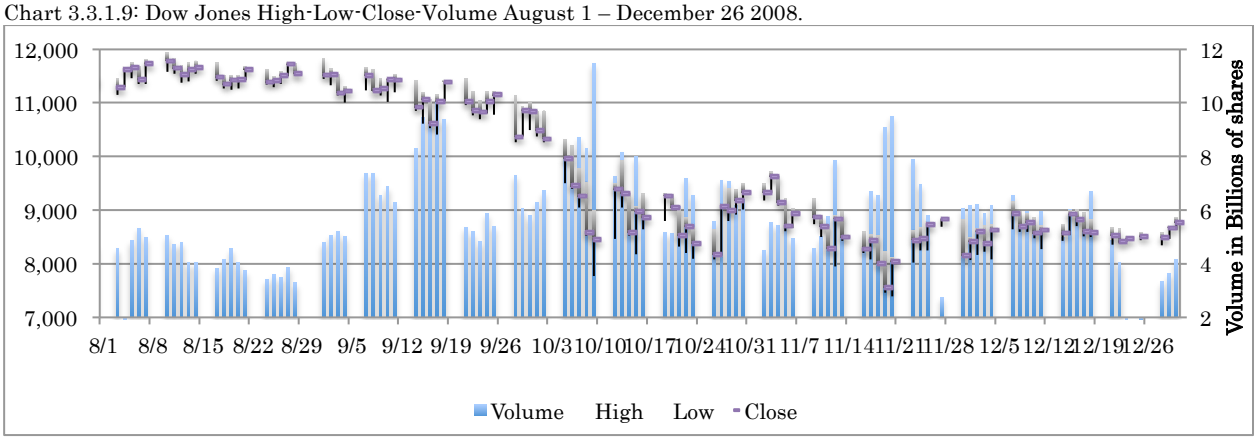
Some claim that the bursting of the bubble was due to the Fed's interest rate policy. It is true that the Fed funds rate was raised six times in 1999 and 2000. It seems unlikely however that an increase from 5% to 6.5% alone would have caused the bubble to burst. It is much more likely that the craze that engulfed the market in 1999 and spring 2000 simply ran out of money and investors came to realize how overpriced most of these

[36] (Shiller 2000), Part Two contains a vivid and detailed account of this period including surveys of investor sentiment
[37] Please refer to the period of the dotcom boom in the analysis oft he Dow Jones Industrial Index in Ch.3
[38] (Glassman und Hassett 1999) p.140 claimed the Dow would reach 36,000 points by 2005
[39] A term coined by Alan Greenspan: (Greenspan 1996)
[40] Microsoft's highest stock price was in Dec 1999 at over $58, Yahoo's in Jan 2000 at over $118, Intel's in Aug at $74.62. These stocks have been trading around $27, $17 and $20 respectively the past 5 years. And let us not forget the AOL Time Warner merger where a young tech company bought a long-established media company only to later even have its name removed from the company as it nearly disappeared like so many others.
[41] In March 2000 the combined market capitalization of all NYSE and NASDAQ companies stood at roughly $18trn, by October 2002 roughly $9trn.

technology stocks indeed were. After the bubble burst in order to stimulate the economy the Fed embarked on a policy of declining interest rates.[42]

3.3.1.5 The 2008 Crisis

Chart 3.3.1.9: Dow Jones High-Low-Close-Volume August 1 – December 26 2008.



3.3.1.5.1 The Crisis in Perspective

The 2008 crisis triggered what has been called The Great Recession. It is the most sever economic crisis on a global scale since The Great Depression of the 1930's. The ongoing crisis is, in many respects, different from any we've seen before[43]. The speed with which it swept across financial markets across the globe, only to spill over into the real economy and the sheer size of the losses in growth and wealth make this crisis a game-changer. Due to the complexity of the underlying problems of the crisis and the problems that developed or were greatly aggravated due to the crisis makes the future anybody's guess. Chronic uncertainty has become the norm. The extent of the crisis-related losses is staggering. In the US alone, losses from decline of home values and stock market reached an estimated $14trn[44]. To this is added the amount spent by governments which reached an estimated $12trn already back in 2009[45]. What makes matters worse is that even according to the Financial Crisis Inquiry Commission, appointed by the United States government to investigate the causes of the 2008 crisis, "… this crisis was avoidable—the result of human actions, inactions, and misjudgments. "[46]

Between 1 Sept and 30 Dec 2008 the DJI went from closing price of 12,834.18 to 8,859.56 with a low of 7,162.9 on 27 Oct. The September 2008 – March 2009 period was extremely volatile. Out of the 20 largest percentage gains in the history of the DJI 9 were in 2008 and one in 2009. From the 20 largest percentage losses 11 were in 2008.

---

[42] From 6% in Jan 2001 to 1.75% by end of 2001. Decrease continued unabated to reach 1.25% on Nov 6, 2002 and reach a low of 1% on June 25, 2003.

[43] The dotcom bubble bursting in 2001 was different. The 1996 Asian crisis was different. While the latter did affect markets in the West in a significant way, however world economy was not as severely disrupted as it has been in the 2008 crisis. Traditional wisdom would suggest that this is to a big part due to the fact that the 1996 Asian crisis was created in countries at the periphery of the world economy whereas the 2008 crisis was 'Made in USA'. The last time a financial crisis of this magnitude started in a core world economy country was in 1929 and was also 'Made in USA' only to spread to the rest of the world. This idea is underlined in (Stiglitz 2009) p. xiv-xv,

[44] (Luhby 2011)

[45] (Conway 2009)

[46] (Financial Crisis Inquiry Commission 2011)

3.3.1.5.2 The Timeline

Chart 3.3.10: GDP quarterly percentage change, 1st quarter 1999 to 2nd quarter 2011

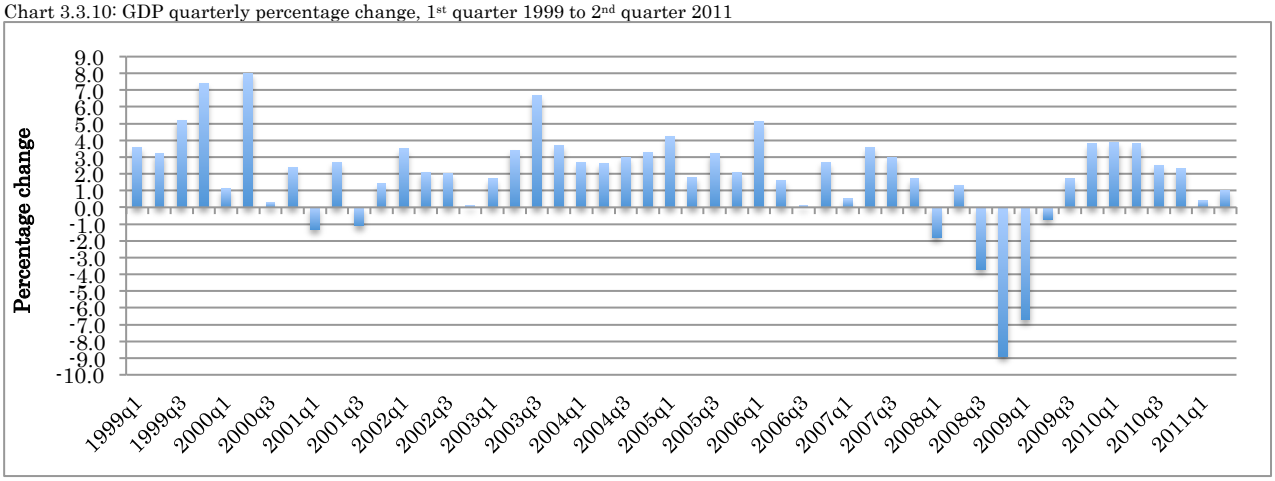
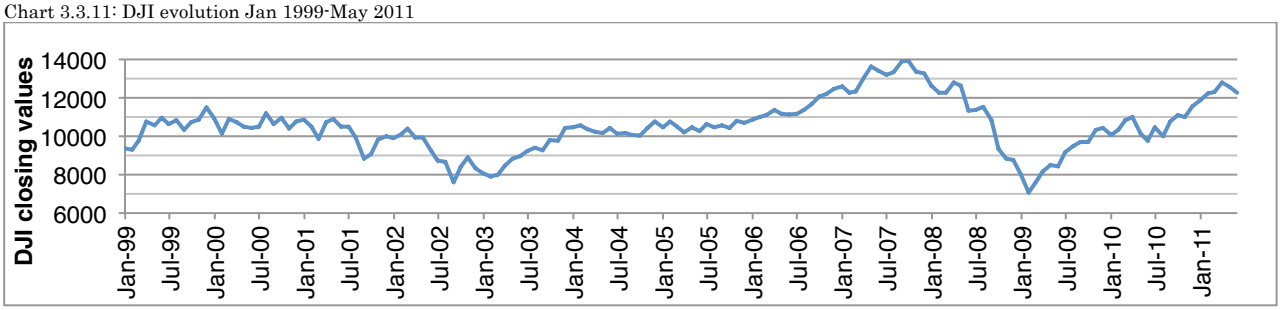


Chart 3.3.11: DJI evolution Jan 1999-May 2011



In spring 2000 the dotcom bubble burst[47]. The Bush administration's response was lowering taxes[48] and debt-financed spending[49]. September witnessed the terrorist attacks which greatly affected the attitude of the American people and economic growth was sluggish to say the least in 2000-2002. The 2001-2002 lowering of the interest rate was quite extraordinary, especially in the light of historical Fed funds rates[50].
By early 2003, economic recovery had begun in earnest. It is hard to estimate the effect of the Invasion of Iraq on American economic output but one could speculate that the combined spending of both wars provided a strong stimulus[51] [52]. As growth accelerated and inflationary fears became relevant once more, the Fed started increasing the interest rate on 30 June 2004 and continued until June 2006[53]. Growth in 2006 showed that there might be trouble ahead. In 2007 quarterly growth became erratic and showed steady decrease. In response to this economic weakness, monetary easing was again decided on and the federal funds rate was subsequently decreased to 4.25% at the end of 2007. Markets in the meantime soared till September 2007.
Between March 2003 and October 2007 the Dow Jones Industrial went from the vicinity of 7,700 points to just above 14,000. That is an almost doubling within four and a half

[47] The NASDAQ reached its historic high on March 10, 2000.
[48] Economic Growth and Tax Relief Reconciliation Act of 2001. (United States Congress 2001)
[49] Government debts rose by 7.1% (as percentage of GDP) over the first presidential term. Discretionary spending, chiefly defense has also increased greatly with the advent of the Invasion of Afghanistan and later that of Iraq.
[50] Since 1971 the lowest the Fed funds rate has been was in the vicinity of 3.5%, never lower than 3% though, up until 2001 that is.
[51] The US spent 4.8% of it's GDP on defense. This is 2010 data, which entails significantly less costs compared to pervious years, when the situation in Iraq was much worse. (The Economist 2011)
[52] It is estimated that about 5 million people are employed either directly or indirectly in defense-related jobs (Pollin und Garrett-Peltier 2003)
[53] The raises were incremental (by 25 basis points) to reach a high of 5.25% on June 29 2006.

years. This gives an average growth of roughly 14% p.a. What is even more interesting is that we witness two periods of very strong increase in the index: March till December 2000 and July 2006 to July 2007. What is also especially important is that the growth while seemingly relentless was also very stable. Thus the period of low market volatility during the boom.
In hindsight we know that one of the strongest driving forces behind the boost was the subprime mortgage market. In this period house prices soared[54]. Subprime lending has gone through unbelievable growth. $30bln in subprime lending was a strong year in the 1990's, in 2000 there had been $130bln. Of which $55bln would be repackaged into bonds. In 2005 there would be $625bln of subprime lending of which $507bln would be repackaged into bonds. In 1996, 65% of subprime loans would be fixed-rate while in 2005, 75% would be floating-rate[55]. In this period the subprime derivatives market went through meteoric rise just as the quality of the loans went through a meteoric fall[56].

Since the 2008 crisis most everyone knows about, and loathes the very name of, such derivatives as CDOs and CDSs. Description of these financial vehicles and the story of what lead up to the market crash of 2008 are beyond the scope of this paper. The short story is that a huge derivatives market had been built based on the subprime mortgage market under the assumption that real estate prices will at worse stop growing but never decline nationally, because that is what the past seven decades have taught us. By summer 2006 however, the impossible had happened. Home prices in the U.S. have started to decline[57].

It was in early 2007 that losses from the subprime derivatives market started hurting many of the biggest banks and financial institutions while other mortgage-related institutions were nearing or going into bankruptcy. Banks started reducing lending to each other, 'credit crunch' started taking hold. In August troubles in the markets intensified. On August 9 the European Central Bank pumped €95bln into the European banking system. The Fed and Bank of Japan took similar steps. The next day, August 10, central banks in Europe, US made further steps to alleviate liquidity problems in the banking sector. On September 4 overnight bank lending practically dried up[58]. By mid-November Goldman Sachs estimated losses from the subprime crisis could be as much as $400bln.[59] Around this time problems at Freddie Mac and Fannie Mae, the two government-sponsored enterprise mortgage behemoths, started to surface in earnest.

Between 1 Jan 2007 and 1 Jan 2008 the Dow Jones Industrial went from a low of about 12,000 points to a high of 14,000 in mid-July only to drop below 13,000 a month later, then to climb to it's all time high in October, drop more than 1000 points again and climb back to close to 14,000 once more.

2008 continued in the same way that 2007 ended, downhill. Till April, however, it seemed that the downward trend might reverse and the market recovered from 12,000 to

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[54] (S&P Case-Shiller Price Indices 2011): Constant-quality, 20-city composite index based on repeat sales of single-family homes compiled by Standard & Poor's. The index has risen from 138.37 in March 2003 to a maximum of 206.52 in May 2006, stayed relatively stable in the 190 region till September 2007 only to decrease to the 140 region by summer 2011
[55] (Lewis 2010) p.23
[56] (Soros 2008) p.xiii-xxiv is the most concise narration that I have come across in my research and a summary of this follows, at times with direct quotation
[57] (S&P Case-Shiller Price Indices 2011)
[58] (BBC News 2007) Sep 4.
[59] (BBC News 2007) Nov 26.

13,000 and held there till mid-May. The next two months though brought a 2,000 point drop, or about 15%. This is down roughly 20% since the October 2007 high.

A short timeline of the most important events of 2008 is as follows:

March 14	Bear Stearns receives emergency funding after a run on its investments
March 17	Bear Stearns government-sponsored takeover by JPMorgan at $2 share price
September 7	Fannie Mae and Freddie Mac, the two government-sponsored enterprises, behemoths of the mortgage market enter into government conservatorship
September 14-15	Lehman Brothers allowed to fail after frantic negotiations to be sold or merged with. This decisions is viewed in hindsight as a great mistake and the trigger of the global financial tsunami
September 14	Merrill Lynch sold off to Bank of America, at an in hindsight strongly overestimated price.
September 16	AIG nationalized, with almosmt all stockholder value wiped out. Price tag: $85bln
September 22	Morgan Stanley, Goldman Sachs: the two last big Wall Street investment banks, the pinnacle of high finance, become bank holding companies, effectively declaring the broker-dealer-investment bank model dead; Part of Morgan Stanley sold to Mitsubishi UFJ
September 25	Washington Mutual files for bankruptcy: scooped up by JPMorgan Chase; largest commercial bank failure in the history of US
October 3	Emergency Economic Stabilization Act, which created the $700bln Troubled Asset Relief Program, passes Congress

3.3.1.5.3 Aftermath and the Present

What happened since the signing of the TARP is already part of history. It seems very likely that markets will be subject to increased volatility in the coming years. The current European sovereign debt crisis, while not created by the 2008 crisis, was most certainly exacerbated by it greatly. With sluggish growth, no growth or even recession, the chance of a downward spiral of ever-increasing debt and no growth has increased greatly.

With the US and Europe stuck in slow growth and seriously jeopardizing the global financial markets in case of default of one of the Euro zone countries the outlook is grim.

3.3.2. The FTSE 100

Chart 3.3.2.1: FTSE evolution March 1973-March 2011. Horizontal axis denotes first trading day of January of the year.

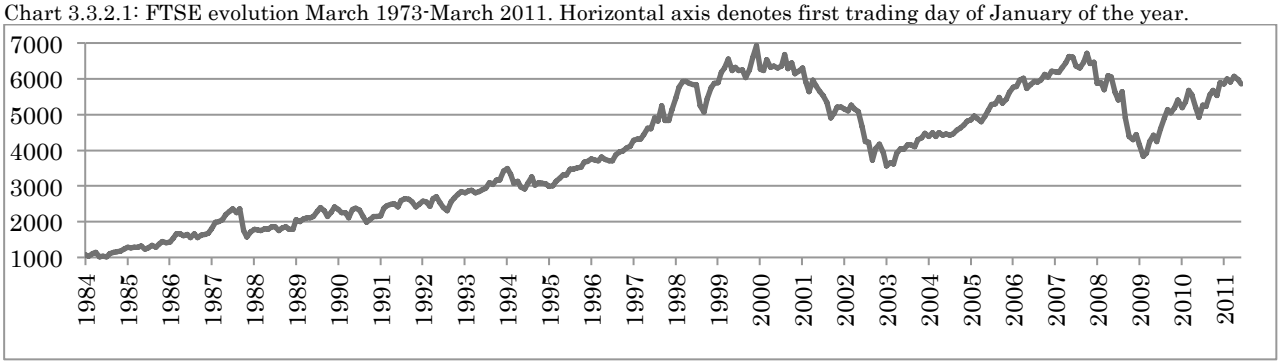


Chart 3.3.2.2: FTSE quarterly volatility with monthly data March 1973-March 2011. Horizontal axis denotes first trading day of January of the year.

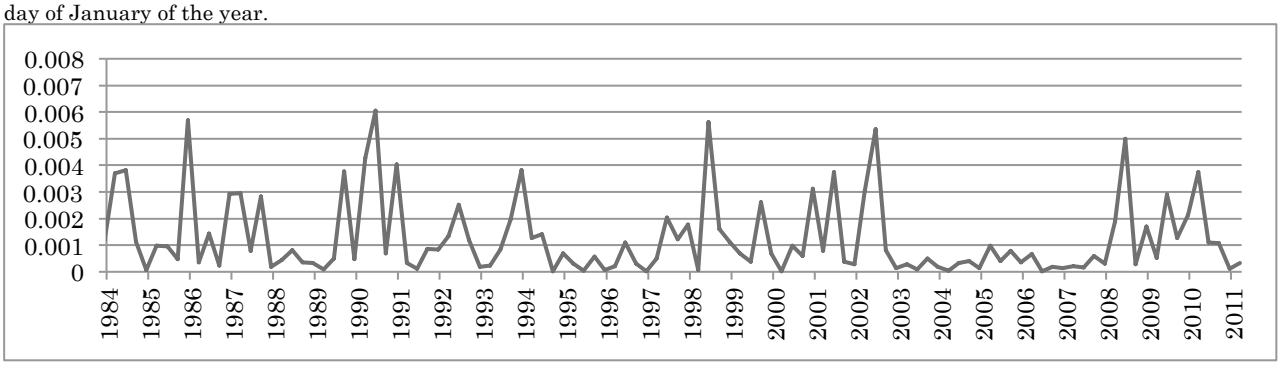
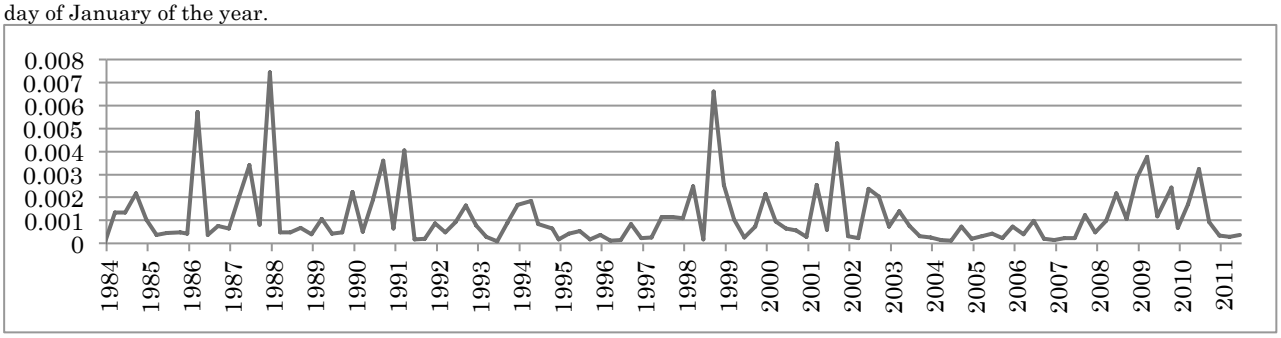


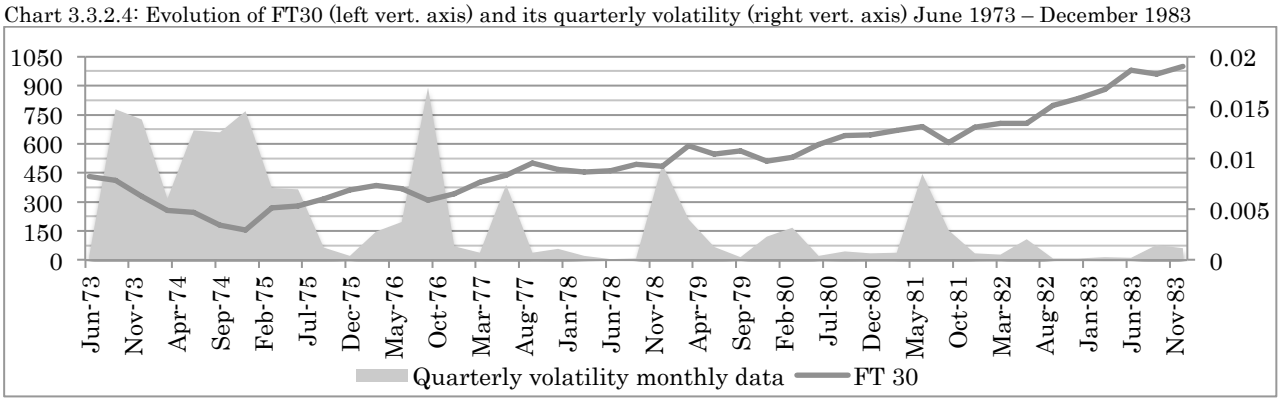
Chart 3.3.2.3: FTSE quarterly volatility with weekly data March 1984-March 2011. Horizontal axis denotes first trading day of January of the year.



First, let us start with a little excurses about the data. The FTSE 100 exists since 3 Jan 1984 with a starting value of 1000. The FT 30, whose basket of stocks is very different from that of the FTSE 100 is calculated since 1 July 1935. I have found a dataset[60] that contains end of month-adjusted values of the FT 30 in relation to the FTSE 100 for dates prior to 3 Jan 1984. Thus, the values from the period prior to 1984 are only a very imprecise approximation of the latter FTSE 100. However, in my opinion, it still retains some merit, thus I decided not to discard this data, however, this period will be analyzed in less detail however.
The decade 1973-1983 is one of particularly significant turbulence in the market. In the following graph the red line is the evolution if the FT 30 and the blue surface is the quarterly volatility.

[60] (Wren Investment Advisers 2011)

Chart 3.3.2.4: Evolution of FT30 (left vert. axis) and its quarterly volatility (right vert. axis) June 1973 – December 1983



3.3.2.1 1973-1983

The period 1973-1975 was quite tumultuous in the UK. Politically, there was much tension in Northern Ireland. The period from the end of the 60's till the Belfast 'Good Friday' Agreement of 1998 is also called 'The Troubles' with the worst of the worst at the beginning of the 70's. Added to this political tension were the oil shocks (as already mentioned in discussion of the DJI index) and high inflation. The UK economy was even more exposed to the oil shock, as the UK's domestic oil production was at the time even smaller relative to its consumption than that of the US. The North Sea oil fields were not producing very significant amounts of oil yet. Most of the larger fields were only in exploration phase at that time.
Stagflation persisted through end of 1977 and the increased volatility in summer 1976 can be explained to some extent by the great heat wave and drought of that same year. This was the hottest summer on record.

The economy started showing signs of recovery by 1978. The spike in volatility of winter 1978-79 can be attributed to what came to be known as 'The Winter of Discontent', which consisted of a series of strikes that practically paralyzed the country.

A May 1979 saw the victory of the Conservatives and that of Margaret Thatcher into the position of Prime Minister. Next spike in June 1981 can be explained by the extensive rioting in England with focal points in London, Birmingham, Leeds and Liverpool. These riots were race-related. One of the results of Thatcher's monetarist stance on fighting inflation led to the closure of many inefficient factories which in turn gave way to greatly increased unemployment. This affected mostly the working class, which had a great proportion of visible minorities, especially migrants from the Commonwealth who came to the UK to work in low paid jobs in the 60's and 70's. It was especially this already underprivileged class that suffered the most, leading to great tension, particularly in those neighborhoods that saw a high concentration of these workers who lived in bad conditions and were now stricken by severe unemployment.

Interestingly, no significantly higher volatility can be attributed to the Falkland War.

3.3.2.2 1984- September 1987

With January 1984 we start dealing with a different index, the one that is our main focus, the FTSE 100. Looking at a graph summarizing the period 1984-1991 could help us get a better grasp.

Chart 3.3.2.5: Evolution of FTSE100 March 1984 – Dec 1991

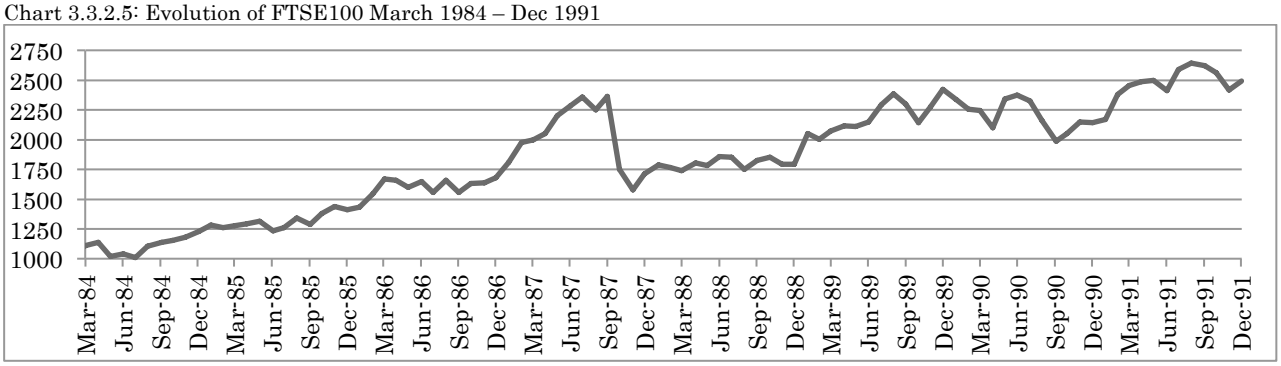
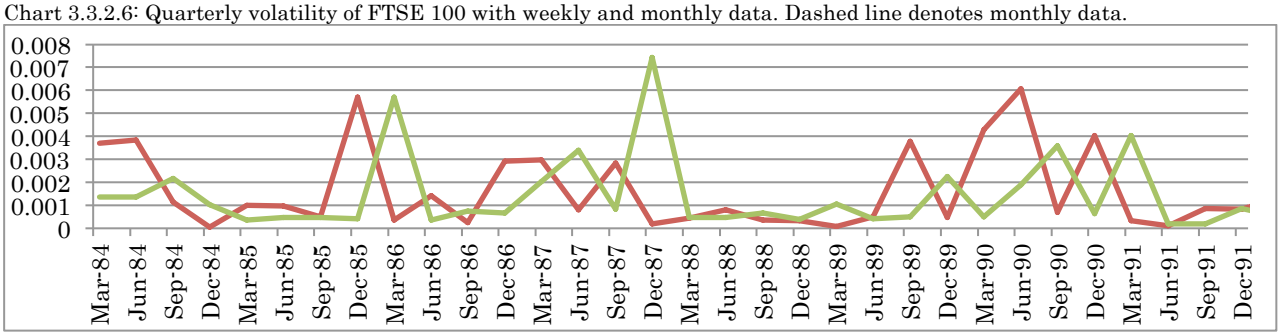


Chart 3.3.2.6: Quarterly volatility of FTSE 100 with weekly and monthly data. Dashed line denotes monthly data.



In this graph the differences in variances using weekly and monthly data are strong. First example is that of the increased volatility in the monthly data at the beginning of 1984. First two quarters show much larger volatility than using weekly data. We see on the graph that first 3 quarters of the year have seen decrease in the FTSE 100 and as of July quite a bullish market. The spike in monthly data for the 4th quarter of 1985 is kind of a surprise, explained by a strong increase from 1290 point at the end of Sept to 1668.8 at the end of March, which is an increase of 29.3% over 7 months and is very impressive especially if we consider the fact that the period between 11 Nov and 27 Jan (these are Fridays) has seen no increase. We have the interesting combination where the monthly data mirrors higher volatility in the last quarter of 1985 and much lower in first quarter of 1986 while the weekly data shows the exact opposite. Nevertheless, we can conclude that this period is one of instability.

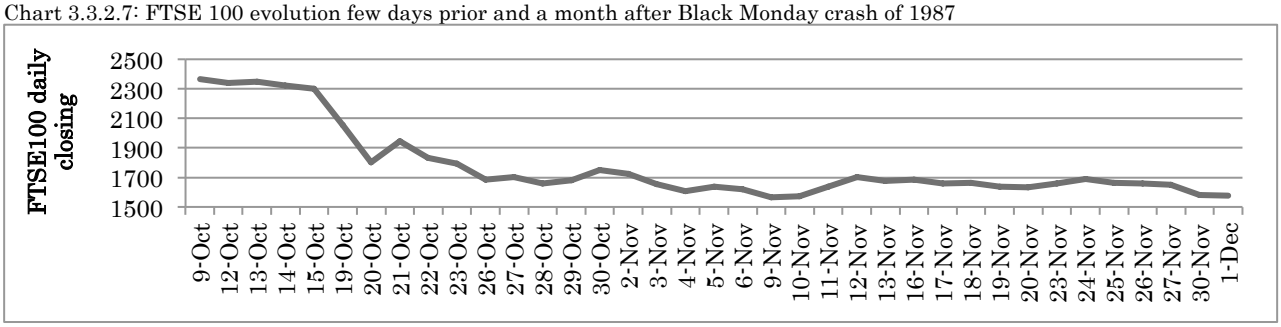
Next spike that shows up in both monthly and weekly data (although with a lag in the weekly) and can be attributed to the 'Big Bang Day' on 27 Oct 1986 is when the new rules of the London Stock Exchange changed as part of Thatcher's deregulation package. Many attribute the very strong bull market that was to follow for nearly a year to this change in policy. On 27 Oct 1986 the FTSE 100 closed at 1662.7 points and on 28 Sept 1987 it reached 2360.9 points, which is an increase of 41.99% over a period of less than a year. Periods of strong growth tend to be more volatile than periods of slow growth. Many argue that it was Thatcher's policy that saved London as a financial center. By the mid 80's London and British banks had lost their appeal in many regards and had become less competitive, many argue exactly due to poor regulation. This new regulation, or lack thereof is widely regarded as having (again, arguably) restored London's status as the primary financial center in the world, a title that has been lost to New York for a while. These changes have influenced the face of banking in the UK in different aspects as well. Many foreign banks and other financial institutions have moved in and indeed, on the whole are more important players than native British institutions in the FTSE100 index. As mentioned earlier, many of the FTSE 100 companies conduct most of their business overseas. Indeed, the London Stock Exchange

is one of the most international stock exchanges in the sense of listed firms and listed firms' activities overseas.

3.3.2.3 Black Monday, October 19 1987

Ironically enough the Black Monday collapse of October 19 1987 does not show up in the monthly data. Explanation is simple. The crash happened with dizzying speed at the end of October. The market was relatively stable afterwards. Thus since the monthly data uses the closing value of the last day of the month, this volatility was not captured in this aggregated data.

Chart 3.3.2.7: FTSE 100 evolution few days prior and a month after Black Monday crash of 1987



Explanation of what happened on Black Monday on the London Stock Exchange is just as fraught with difficulties as the previous explanation of what happened on the New York Stock Exchange. There are of course many similarities but significant differences abound. The market hasn't moved significantly throughout September and up to 15 Oct. This bears a strong similarity with the Dow.
In order to get a feel for the timeline of the events of 19 Oct 1987 let us look at the opening hours of the various financial markets around the globe. The Tokyo Stock Exchange opens at 00:00 UTC (Coordinated Universal Time) and closes at 08:00. Hong Kong opens at 01:20 and closes at 08:00. London opens at 08:00 and closes at 16:30. New York opens at 14:30 and closes at 21:00.This is important as these markets tend to move in unison. Even more so when crises develop in one, influence is immediately exerted on markets that are open at the same time. Those that are closed usually trace the other markets in the following session.
On Friday 16 Oct the LSE remained closed due to The Great Storm of 1987 that occurred the night before. Traders in UK watched as the DJI dropped 108.35 points or 4.6% on Friday, not being able to react as their own market was closed.
Traders with the bad memories of last Friday's Great Storm and the precipitous decline in the Dow paired with bad news from the Far East, the Nikkei closed down 2.4%. Much more importantly though, the Hong Kong Stock Exchange's Hang Seng index closed a whopping 11.11% down, just as the London Stock Exchange opened trading. In 1987 Hong Kong was still a dependent territory of the United Kingdom and had a very close relationship with the UK, especially in finance and banking. Numerous stocks were actually cross-traded on the LSE and HKSE. Thus, this trifecta was quite the shock for the London market, which started trading considerably lower. From bits of information from different news sources the day followed much in the same vain. Then the New York market opened, also considerably lower. By this time sentiment was vastly negative on

the LSE and in the two hours when the LSE and NYSE are both open the outlook soured some more and led to a 10.84% loss by the end of trading[61].
As the crash developed in New York, the other markets the world over 'followed the leader' After the negative evolution in Far East markets that have very strong ties with or even list cross-traded companies with the London Stock Exchange it was only natural that the FTSE 100 would follow with a strong decline. 20 Oct 1987 is to this day the largest percentage drop in the FTSE100 with 12.22%. It must be noted that the combined two-day drop perfectly traced the 19 Oct losses of the Dow.
It seems that the first day of the crash was the result of a very specific set of circumstances where the total effect was more than the sum of its parts. I have no knowledge of studies similar to that of the *Presidential Task Force on Market Mechanisms*[62] that would suggest program trading and similar technical reasons for the crash. So one could argue that in the case of the UK the crash on 19 Oct was more of an 'old fashioned' one. The second day was just an alignment and response to the evolution to the other markets.
It should be noted that similar to the Dow, it took somewhat less than 2 years for the index to climb back to pre-crash levels.

3.3.2.4 1990-1991

The increase in volatility, just as for the Dow can be attributed to the spike in oil price due to the tension surrounding the armed conflict in the Gulf of Persia, Invasion of Kuwait by Iraqi forces and the subsequent NATO retaliation. That conflict however did not persist and soon oil prices stabilized. It did however lead to .8% growth in 1990 and -1.4% for 1991.

3.3.2.5 1998-2000

As mentioned earlier, the UK still has very strong economic ties with countries that used to be part of the British Empire. In 1997-1998 it was these countries that were going through a severe economic crisis. So naturally, the UK economy and by extension the performance of the FTSE 100 was influenced in the process. However, the 1994-2000 period was one of exceptionally strong growth. The Asian crisis, in the end only lead to an increased volatility in the market, combined with a minor reduction in the value in August 1998.
This growth seems even more out of ordinary when put in context. GDP growth averaged around 3.7% annually in the aforementioned period. The FTSE 100 more than doubled in this period and reached its historic peak of 6950.6 points on 30 Dec 1999.
The latter years of the boom were fueled in the UK just like in the US by the Dot Com Bubble. Similar excesses as to the ones in the US, such as in hindsight extremely overvalued initial public offerings were also present in the UK.
The bursting of the bubble lead to highly increased market volatility as the valuation of internet and technology stocks suddenly shifted and most of the value of technology-related stocks plummeted. In the case of start-ups in many cases almost all shareholder value was wiped out.
Moreover, many of the Far Eastern economies were especially hit hard as much of the growth came from information technology related industries, which of course suffered severely in the following years due to decreased demand and supply overcapacity. As

[61] Interestingly enough, this piece of news, while it probably played an significant role in the crash of the Dow, can not be considered to be the spark that ignited the sell-off. Most of the Dow loss was towards the end of trading, when the London market had been closed for hours.
[62] Please refer to the Dow Jones Industrial index analysis, footnote #13

mentioned earlier the UK has strong economic ties with these countries, many companies that are part of the FTSE 100 do much of their business in these countries. Thus there were manifold reasons for the decrease in the FTSE 100 over the following years.

3.3.2.6 The Dot Com Bubble

The Dot Com Bubble in the case of the FTSE has been especially strong. Between 1995 to 2000 the FTSE grew from around 3,000 points to almost 7,000. That is a more than doubling in 6 years, which translates to a yearly increase of around 15%, which over such a long period of time is quite exceptional. Unlike the DJI, the FTSE reached its historic high at the peak of the Dot Com Bubble. Two years after the bursting of the bubble the FTSE has shed almost all its gains prior to the bubble, bottoming out around 3,500 points in 2003.

3.3.2.7 The 2008 Crisis

The evolution of the FTSE is very similar to that of the DJI. 2003-2007 have been the expansion years. Over this period and also during the crisis the FTSE was almost perfectly correlated with the DJI. Therefore the FTSE also topped out in late summer 2007 to start declining from there.
Reasons for the 2008 collapse are practically the same as those of the DJI. British banks have become heavily exposed to the US subprime mortgage derivatives market. Royal Bank of Scotland and Northern Rock, among others, were the casualties. The Bank of England acted in a very similar way as the Fed in the US.

It is interesting to note that weekly and monthly data paints similar pictures but many times the magnitude and timing of volatility increases is different. For instance, the highest volatility with monthly data is autumn 2008, when the stock market lost most of its value, whereas weekly data finds that it was the beginning of 2009 that was the most volatile. What both data sets agree on is that the recovery was very volatile with many days showing several hundred point jumps. Many intraday trading sessions witnessed strong, few hundred point, reversals. With the UK facing problems of its own further precipitated by the euro debt crisis and no end in sight it is very likely that we will witness further uncertainty in this market.

3.3.3.The N225

Chart3.3. 3.1: N225 evolution March 1973-March 2011; values for March 1 of each year

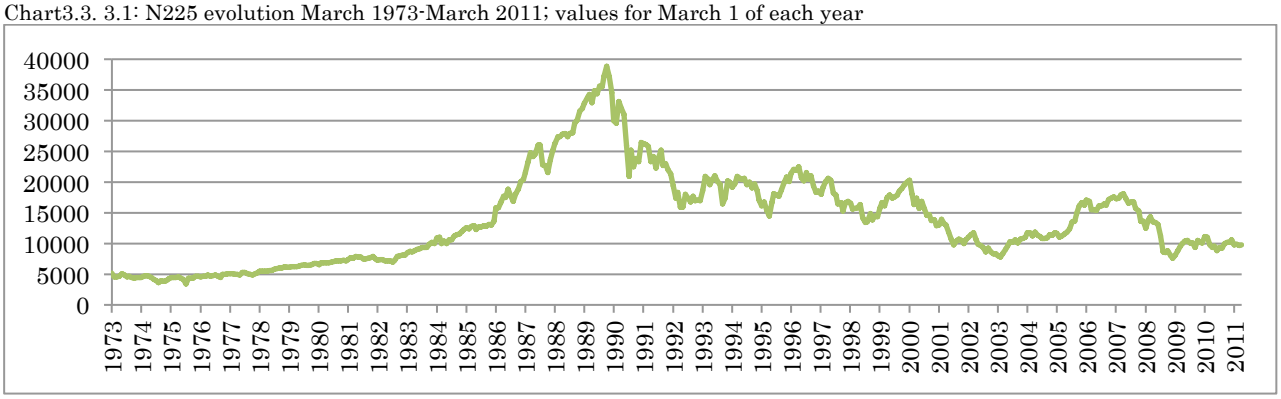


Chart 3.3.3.2: N225 quarterly volatility monthly data March 1973-March 2011

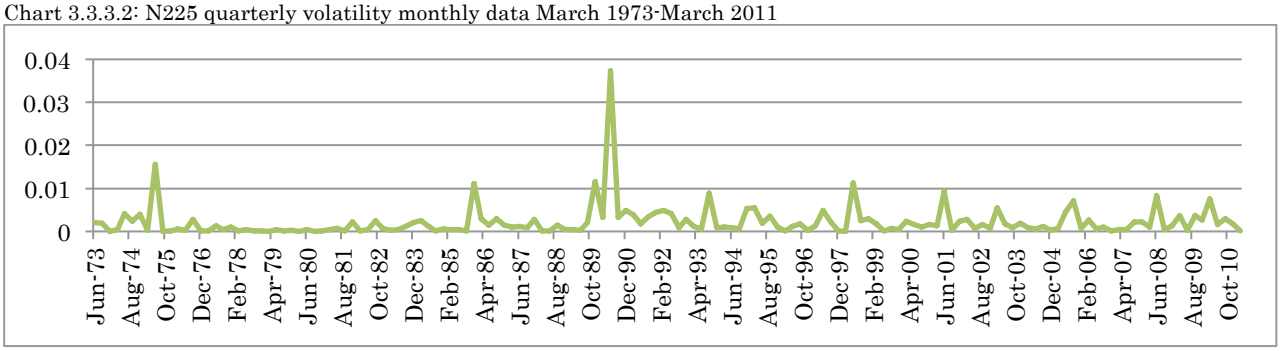
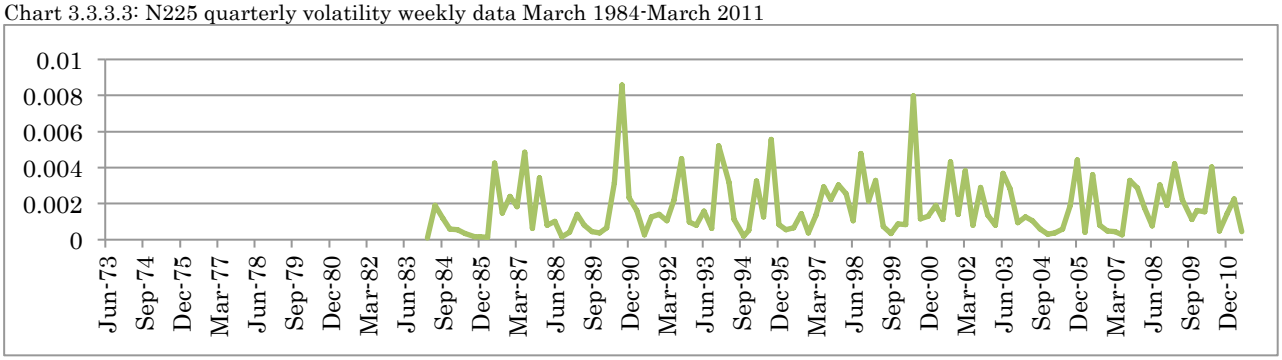


Chart 3.3.3.3: N225 quarterly volatility weekly data March 1984-March 2011



The Nikkei 225, also known as the N225 or just simply Nikkei stock index is the most quoted Japanese stock market index. It is the most important index of the Tokyo Stock Exchange, which is to this day the most highly capitalized stock market in Asia.
In-depth analysis of the Nikkei is more difficult than the other discussed indexes. It is known for higher volatility than either the Dow or the FTSE 100. Many times the index has been subject to unexpected moves and is well known for having significantly different evolution from the other major indexes.

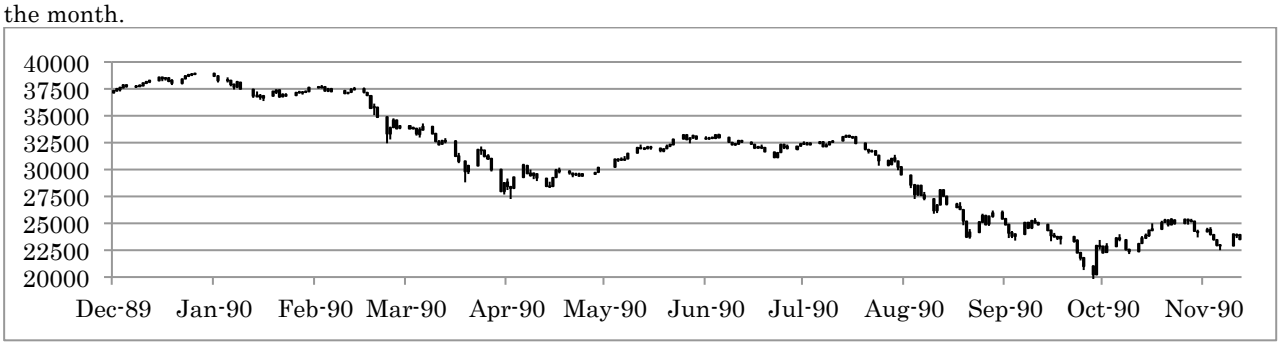
3.3.3.1 1973-1990

The Dow reached its historical maximum in 2008, right before the financial crisis. The FTSE reached its maximum at the height of the Dot Com Bubble.
The Nikkei reached its maximum on 29 Dec 1989, with an intra-day high of 38,957.44 before closing at 38,915.87. The 1980's have seen a tremendous increase in the value of the Nikkei, which started the decade around 6600 points to grow almost six fold within a decade. This gives an average growth of roughly 20% p.a. for the period.

Weekly data was only available as of March 1983. It is quite surprising to see that monthly and weekly data show a quite different picture. There are significant differences in both the timing and magnitude of volatilities as given by the two data sets.
In most cases though, the weekly dataset, which is assumed to be more precise, shows lower volatility. It is especially the medium-strength volatilities that show a marked difference in magnitude from their counterparts using monthly data. Summer of 1990, which has the largest volatility using both datasets shows very different peak volatilities. For the weekly data it is a mere 0.0085, whereas for the monthly dataset it is a staggering 0.04. As we see in the next graph, within 7 months the N225 went from around 38,000 to arund 20,000. That is a decrease of roughly 50%.

The 1990 crash of the N225 is mostly attributed to the bursting of the Japanese real estate bubble, which reached staggering proportions. At the time of the bursting, real estate prices in the financial district of Tokyo have been by far the most expensive in the world. Such a massive loss in value to very strong deflationary pressure and Japan wasn't able to rid itself of it ever since.

Chart 3.3.3.4: N225 evolution December 1989 – November 1990. Horizontal axis denotes last trading day of the month.



3.3.3.2 1991-2011

All of the crises in this period, the 1997 Asian, the 2001 Dot Com Bubble and the 2008 crisis all show up nicely in the evolution of the N225. This is to be expected. However, what is special about the N225 is that there are numerous other bouts of higher volatility that are comparable in size to the aforementioned 3 large crises. This is typical of the Japanese stock market. The political instability, 15 prime minsisters in office since 1991, most certainly adds to this uncertainty. Many of the increases in volatility can be attributed to changes in prime minister.
It is also notable that while there was a considerable recovery in the Western markets after a crash or a bubble, in Japan this is not quite the case. Good case in point is the lack of recovery after the 2008 crisis.

3.3.4. DAX

Chart 3.3.4.1: DAX evolution Mar 1991-Jun 2011. Horizontal axis denotes first trading day of March of the year.

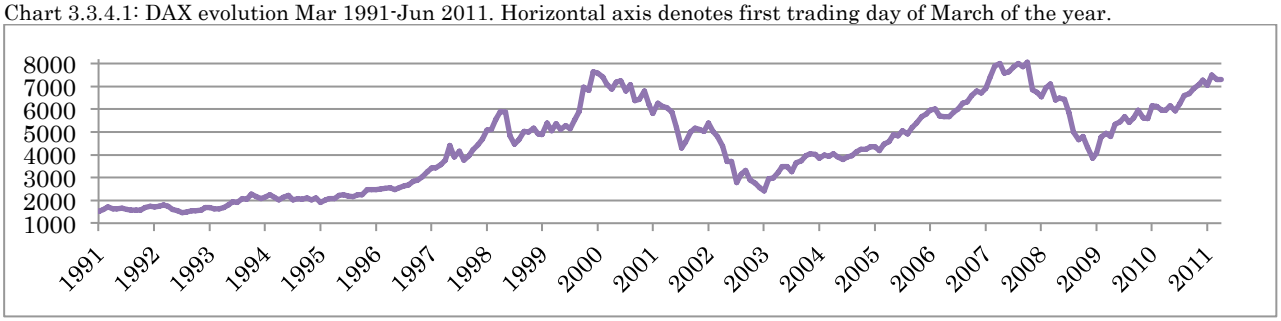


Chart 3.3.4.2: DAX quarterly volatility using monthly data for the period Mar 1991-Jun2011

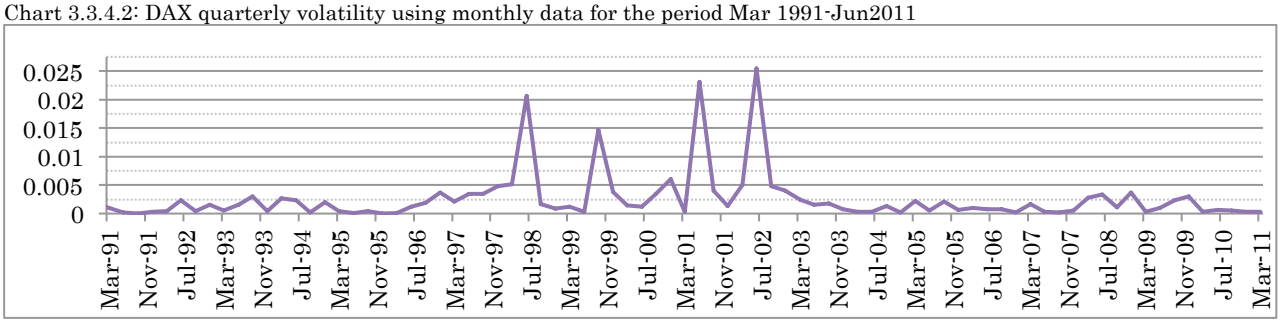
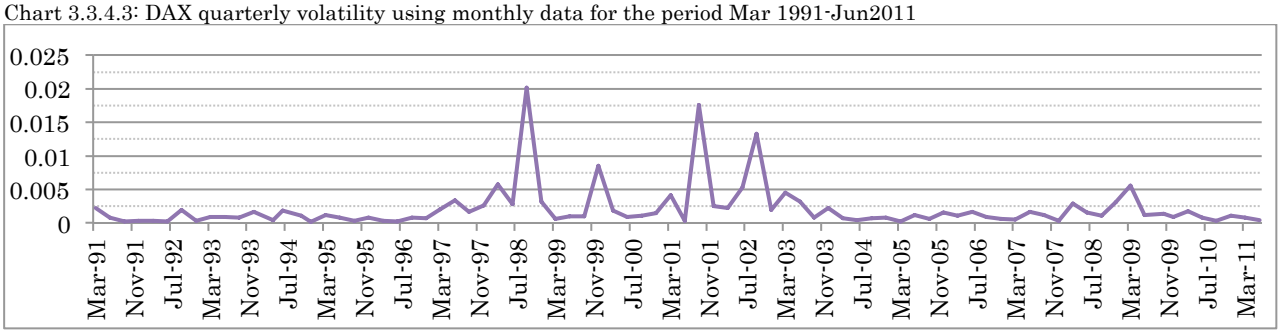


Chart 3.3.4.3: DAX quarterly volatility using monthly data for the period Mar 1991-Jun2011



The DAX has been calculated since July 1, 1988. I however, had available data only since October 1990. Thus my first full quarter is January through March 1990.
At first glance the overall evolution of the DAX is very similar to that of the FTSE 100. After the high at the end of 1999 there was a strong contraction followed by an upswing leading up to the 2007-2008 financial crisis. The DAX however was able to pass the pre Dot Com Bubble crash value, albeit only by a little.
Monthly and weekly data paint a similar picture. The volatility though is much larger in the case of the DAX than in the case of the Dow and FTSE 100. Periods of increased volatility in the case of the American, British and Japanese indexes are usually characterized by volatility in the.006-.01 range.[63] We see that the differences between calm and volatile times are more pronounced than in the other indexes. It is quite intriguing that in comparison the turmoil surrounding the 2008 crash was considerably less pronounced than previous crises.

3.3.4.1 1991-1998

The most striking characteristic of the DAX is that the years 1998-2002 are so much more volatile than the rest of the period. There is a simple explanation for this: The introduction of the Euro. Naturally, it took a while until the member states adjusted

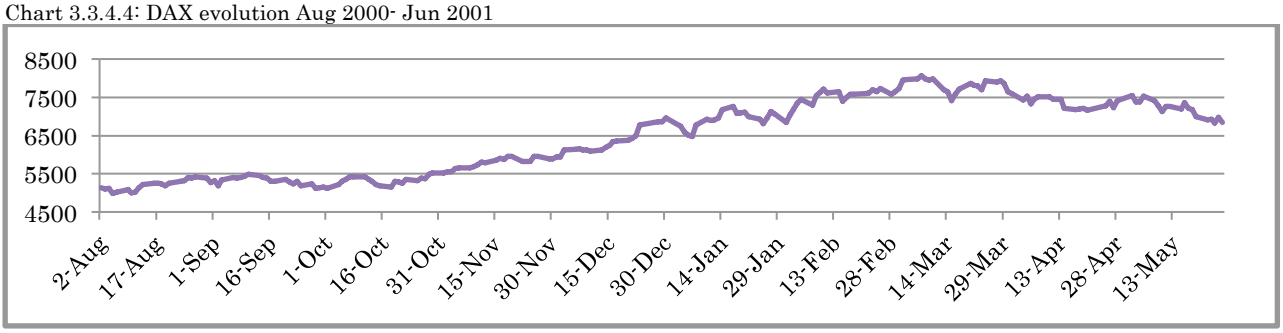
[63] Except some more pronounced spikes in the Nikkei monthly data, especially the spike for summer 1990.

themselves to the new currency and till the new currency became internationally more accepted and trusted.
Four periods of increased volatility can be found that distinctly show up in both the monthly and weekly. As always, the weekly data gives a more precise estimation of volatility.
Explanation for the 1998 spike comes from two areas. One is the Asian crisis of 1997-1998. German industry has and still provides much of the equipment used in the emerging markets of Asia. Therefore, a sudden drop-off in orders could serve as an (at least partial) explanation. Second, and probably more important reason was political.

3.3.4.2 The Dot Com Bubble

The spike towards the end of 1999, beginning 2000 can be attributed to the Dot Com Bubble. As mentioned earlier, this period was characterized by a very high degree of optimism in the markets. The increase in the value of the DAX is tremendous. Between 18 Oct and 3 Mar the index went from 5156.28 to 7975.85 which is a roughly 55% increase within less than half a year. This further shows that sustained and very fast stock market gains are associated by significantly higher volatility, just like times of crisis. The bursting of the bubble while naturally creating higher volatility occurred in a relatively orderly manner, which translated into relatively low volatility and happened over a longer period of time. It took about a year and a half for the market to par the aforementioned gain. One could argue that this is attributable to the strength of the German economy or good policy in the face of the bursting of the bubble.

Chart 3.3.4.4: DAX evolution Aug 2000- Jun 2001



Surprisingly enough, the September 11 attacks explain little of the volatility of the summer-autumn 2001 period. By this time the bursting of the bubble created a period of slow growth in the developed economies. As a matter of fact, recession occurred in Germany, UK, Japan, Korea with the US showing a steady slowdown through 2001.

3.3.4.3 2002-2011

The interesting fact about this period is the greatly decreased volatility. After 2002 the DAX has at instances been even less volatile than the DJI and FTSE. The turmoil surrounding the 2007 peak of the market and the 2008 crash shows up nicely in the data.

3.4 Commodities

3.4.1 Gold

Chart 3.4.1.1: Gold price (nominal) May 1973 - May 2011. Horizontal values denote first trading day of May of the year.

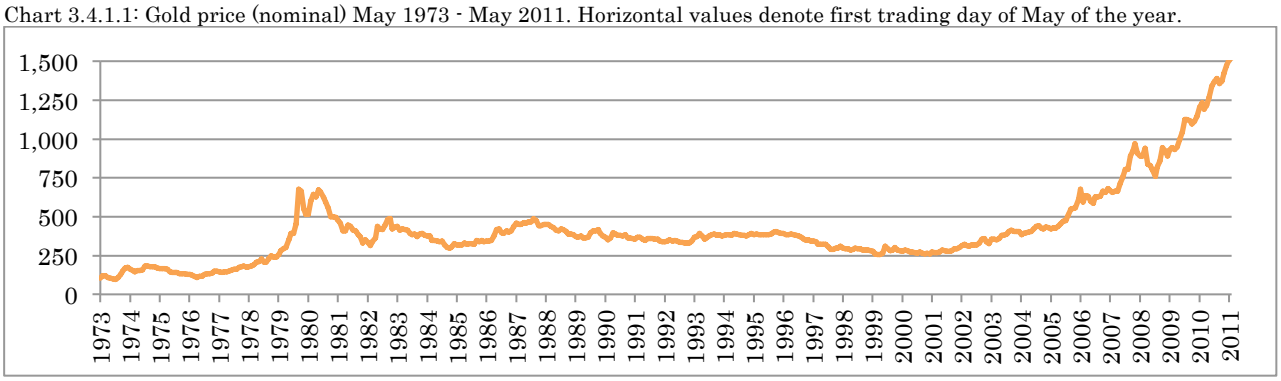


Chart 3.4.1.2: CPI adjusted, yearly values (end of year prices)

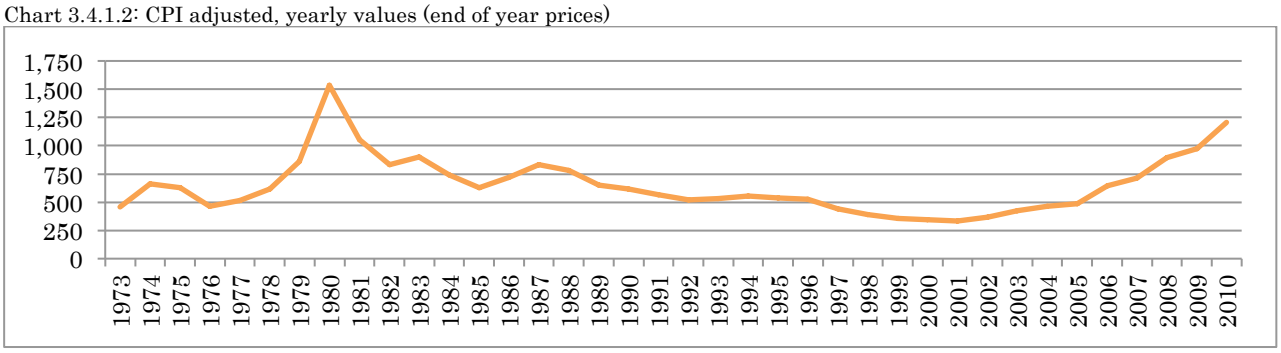


Chart 3.4.1.3: Gold quarterly volatility using monthly data

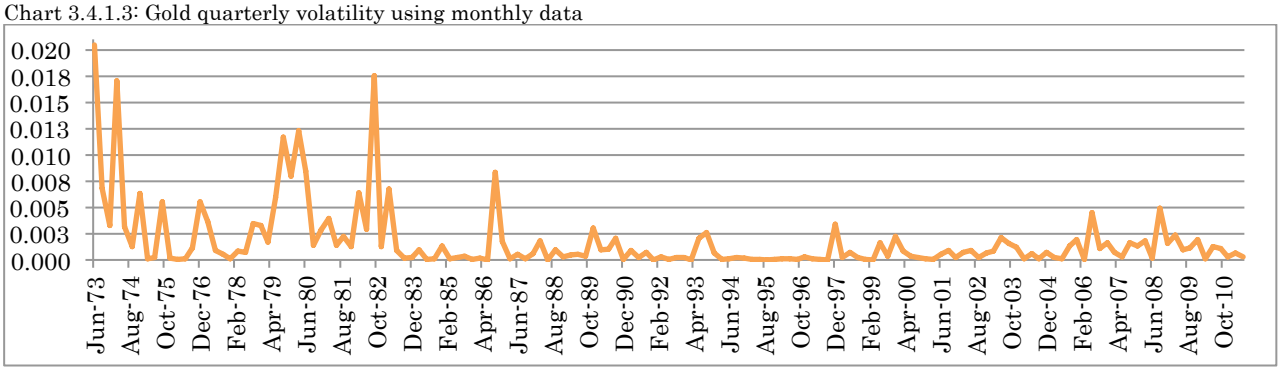
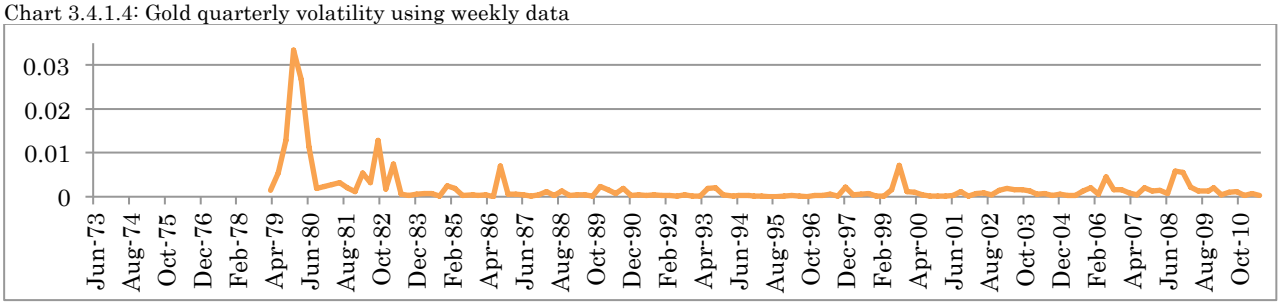


Chart 3.4.1.4: Gold quarterly volatility using weekly data



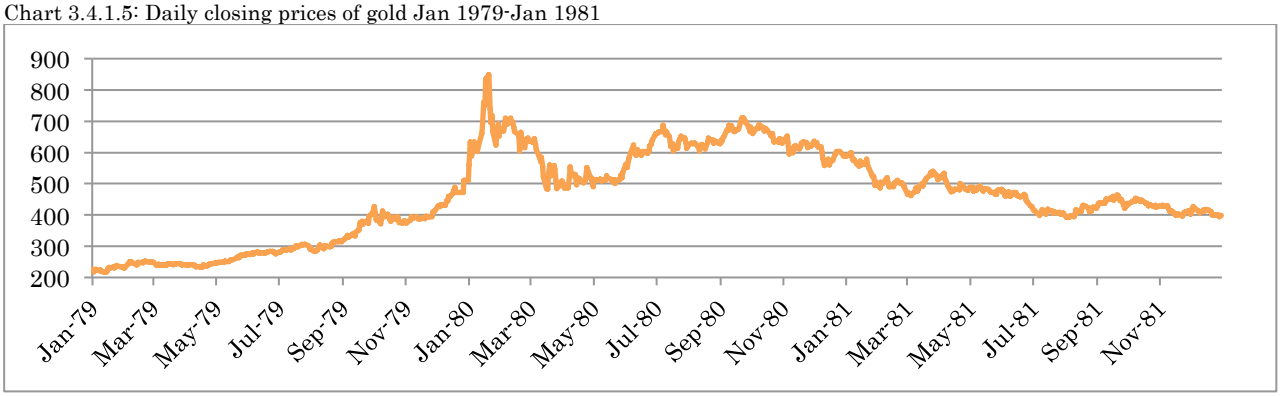
Gold has always been a special kind of commodity. For millenia it has served as store of value and for centuries as the main currency with probably most prominent role as a currency in international trade. It has been universally used, almost without exception, in every area of the world. It has maintained that role even long after the appearance of paper money. Although the convertibility of American dollars into gold has been suspended previously, it was March 1973 that the last elements of the gold standard finally seized. Naturally, the suspension of the convertibility of the dollar had a great

effect on the gold price[64]. There was also great uncertainty regarding what will follow. After all, the gold standard, albeit in a changed form enjoyed a return after World War II. The period of very high price volatility in 1973-1974 can be attributed to this uncertainty as well as to another factor. Just as the Dow and the FT30 were highly affected by the oil shock of this time so was gold. Gold has always been a safety 'currency' or reserve currency. The gold was always held in high regard as being one of the safest investments. Therefore, in most cases, in times of high uncertainty, gold price goes up due to increased demand. 1973-1974 was such a time.

Another interesting characteristic of the gold market is that it is almost exclusively demand driven. The fact that most of the gold that has been mined in the past is still readily available and yearly production of new gold is comparatively very small serves as an explanation to this state of affairs.

The 1979-1980 increase in volatility is the result of extraordinary increase in price.

Chart 3.4.1.5: Daily closing prices of gold Jan 1979-Jan 1981



An ounce of gold cost $226.8 on 2 Jan 1979 and reached a high of $850 little more than a year later on 21 Jan 1980. That is an increase of about 370%[65] in less than 13 months. The increase in January 1980 alone is 66%.
The 1979 energy crisis, the high level of inflation and sluggish growth in the US, Soviet invasion of Afghanistan a few days before the end of 1979, the Iran hostage crisis starting 20 Jan 1980 all fueled the uncertainty and bearishness in the markets. These economic and geo-political circumstances drove the gold price to never before seen heights. Gold reached the same real value again only sometime in July-August 2011. Uncertainty about American reaction to both the Soviet invasion and the Tehran Hostage Crisis further fueled the panic with price reaching maximum the day after the Tehran hostage crisis broke. At the peak, price was above $800 only for two days, above $700 only for 5 days. That is to say, the spike was especially prominent. As the geo-political situation improved, Iranian-American conflict did not escalate and response of US to the Soviet invasion shaped up to be in the form of covert support for Afghan resistance in cooperation with the UK[66].

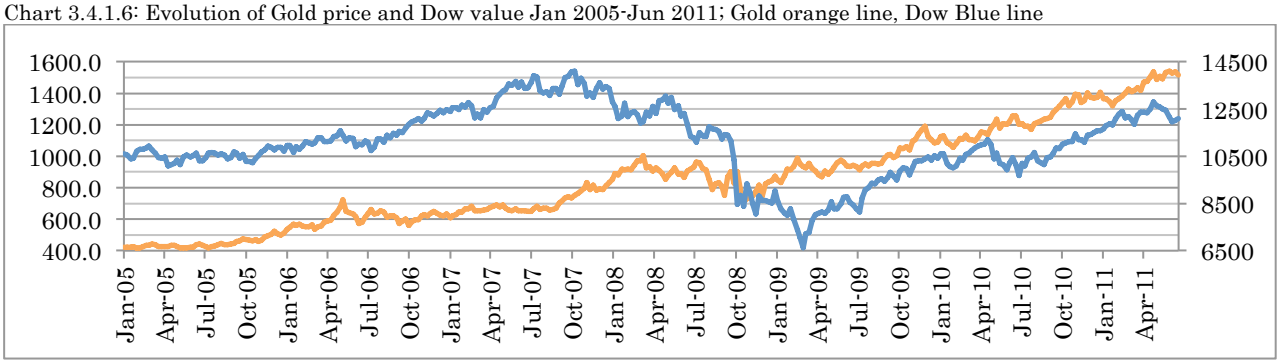
The spike in 1981-1982 can be attributed to the recession in the US which made gold more attractive. As well, the seeming resolution of the Iran-Iraq war in summer 1982 followed by the rejection of Saddam Hussein's ceasefire offer and subsequent Iranian

[64] (Mundell 2000)
[65] For real price increase divide by 1.113 (the inflation rate of 1979 was 11.3%)
[66] And even some limited help from China

invasion of Iraq drove gold price up once more. The 1986-87 spike can be attributed to the conflict in the Middle East. By this time growth was strong in the US.

It is interesting to note that the spikes we have seen in our analysis of stock market indexes can be followed quite nicely in the case of gold also. However, these increases in volatility have greatly diminished. One could argue that in the face of a plethora of new financial assets that allow hedging, gold has lost some of its appeal.
After more than two decades of bear market, gold started significantly gaining value in mid-2005.

Chart 3.4.1.6: Evolution of Gold price and Dow value Jan 2005-Jun 2011; Gold orange line, Dow Blue line



Since then the increase has been relentless.

Why did gold start increasing in value in mid-2005? Hard to tell, but it is certain that gold demand was especially high in this period by Asian central banks. There were rumors about China buying up all the gold it could. Some argue that demand for gold by private investors was also strong *because* the stock market was producing such exceptional gains. Investors who were content with lower returns took up gold into their portfolios. As uncertainty in the marketplace increased and major indexes topped out and started retreating, gold retained its old role of safe investment. Even though the stock market recovered, gold price kept on increasing as well, riding a wave of uncertainty regarding whether the recovery will follow and whether this recovery will be strong enough. As debt problems developed on both sides of the Atlantic gold price increased even faster. It is interesting to note that post-1987 the volatility in the gold market has been much smaller. Gold price has been increasing quite stably after the 2008 crisis.[67]
Since after the crisis and the ensuing debt crisis not only most private financial assets but government bonds have also become less safe, the downgrading of USA's credit rating is just the latest signal, gold became once more the investment of choice to many, seeking safety.

[67] At least until June 2011, when my dataset ends.

3.4.2 Crude Oil

Chart 3.4.2.1: Crude oil price evolution in nominal terms expressed in US dollars for Jun 1980-Mar 2011

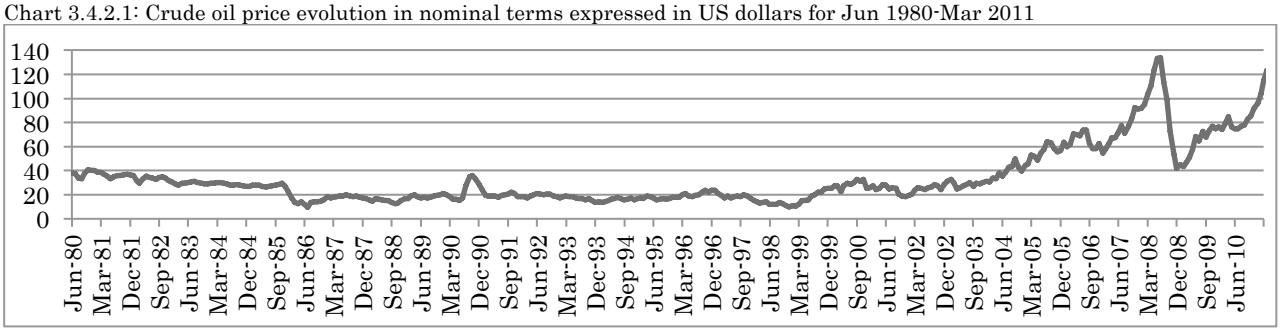


Chart 3.4.2.2: Quarterly volatility of oil price using monthly data

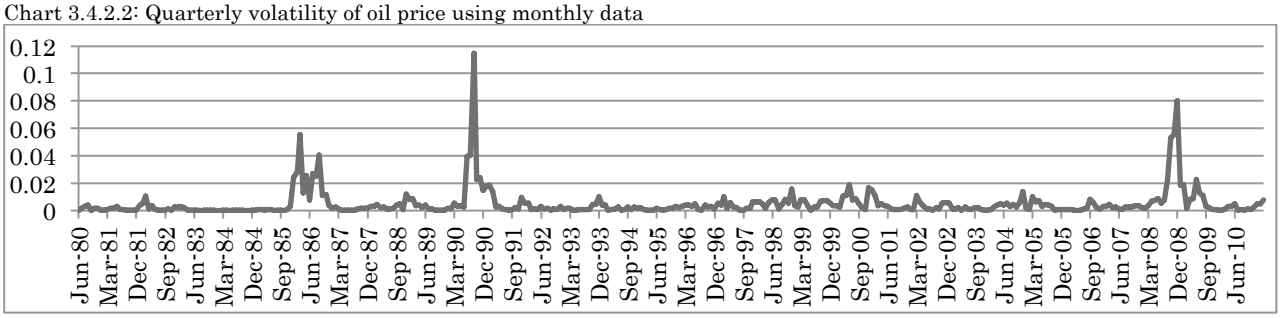
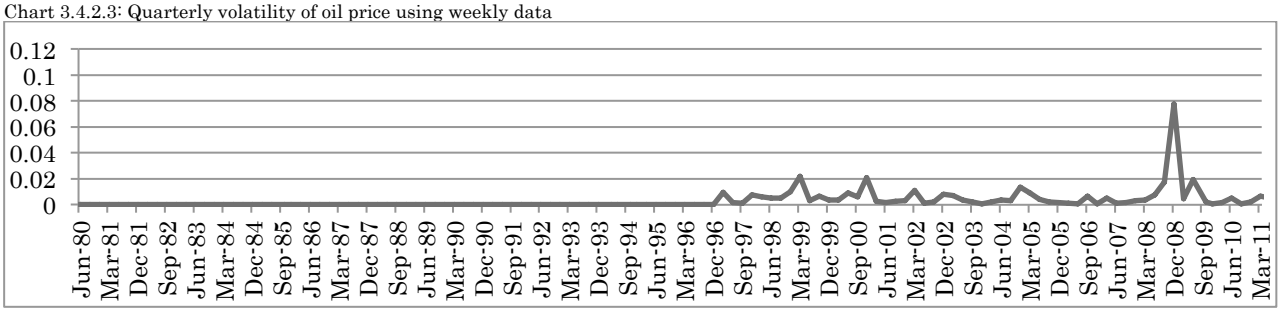


Chart 3.4.2.3: Quarterly volatility of oil price using weekly data



Crude oil price and availability is of utmost importance for the growth (or lack thereof) of every developed economy. There is strong correlation of the stock markets with oil price and a two-way causality is at work.

There are three periods of very high volatility. Two of these have geo-political reasons and the third one is mostly economic.
Sadly, weekly data was available only for the period Dec 1996- present. However, we have seen that weekly and monthly data seldom lead to different outcomes.

The 1985-1987 period was one of economic and geo-political turmoil. In this case the most important factors were the Iran-Iraq war as well as the ongoing infighting between OPEC countries. In this period oil was priced between $9 and $30 per barrel. Oil price went from a high of $29.82/barrel at the end of Nov 1985 to a low of $9.56/barrel at the end of Jul 1986. After the resolution of both the Iran-Iraq war as well as agreement between OPEC nations price stabilized in the $15-$20 range until the First Gulf war.

Iraq's invasion of Kuwait was the trigger for the next spike in volatility. The relationship of Iraq with other states in the Persian Gulf is a very complex one. This war was much closer to the great oil fields of Saudi Arabia that supply crude oil to the Western world than the Iran-Iraq war. As the war broke, supply was somewhat disrupted, but it was mostly the danger of escalation that sent prices soaring, which almost doubled during the war only to recede to pre-war levels once the war ended.

2007-2008 was the third period if exceptional volatility. As we see in the following chart, oil price increased from around $50/barrel at the beginning of 2007 to around $135-$140 in summer 2008 only to be followed by a very strong drop, in unison with financial markets, to around $35/ barrel by the end of 2008.

It is arguable that this was the first instance demand from rapidly growing markets, both developed and developing outstripped production capacity. It is very likely that we are either living in or have already passed 'peak oil'. That is the period where world oil production has passed it's peak and from here on production will not be able to keep up with demand and indeed decrease in amount. There is a great deal of literature on this issue, with serious ongoing debate about future trends. That however, is outside the scope of this paper.

Other economic events of great importance can also be tracked in the data as periods of higher volatility. The 1996-1997 Asian crisis, 1998 Russian crisis[68], 2001 Dot Com Bubble bursting can all be identified.

3.4.3 Industrial commodities

Chart 3.4.3.1: Price evolution of Copper, Aluminium and Coal for Jan 1980 – Jun 2011. Horizontal axis denoting last trading day of January of the year.

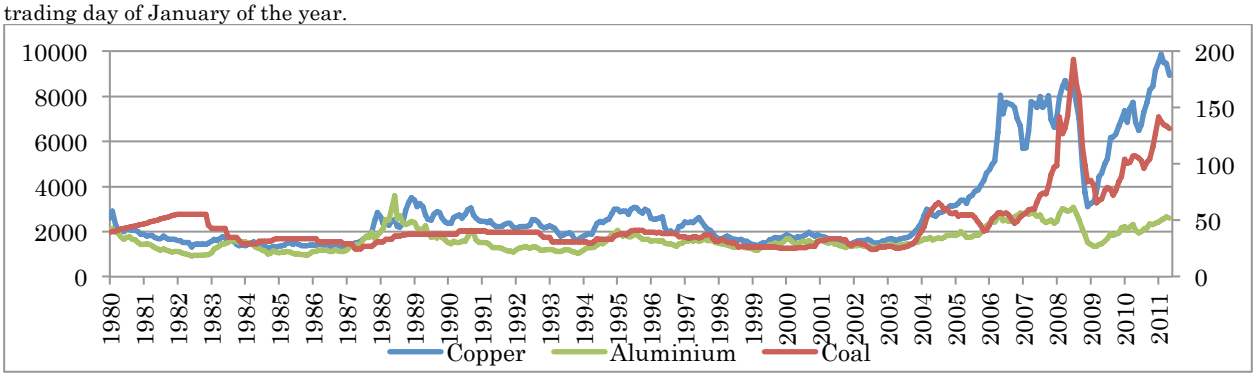
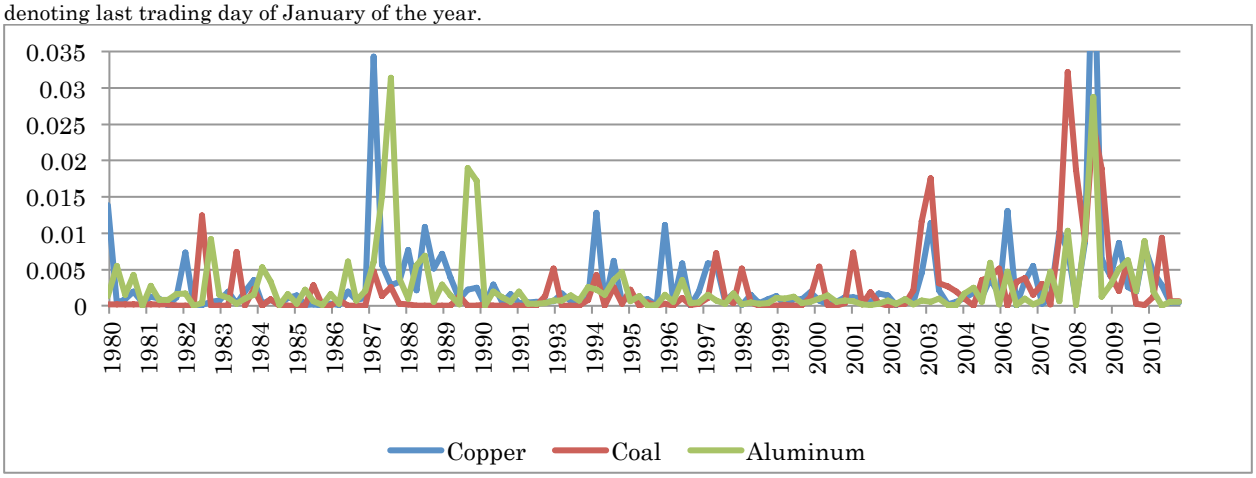


Chart 3.4.3.2: Quarterly volatilities of Copper, Aluminium and Coal for the period Jan 1980 – Jun 2011. Horizontal axis denoting last trading day of January of the year.



We see that although there is considerable variation in price of Aluminium, the trend is one of steady price. At the beginning of 1980 Aluminium cost around $2000 per tonne and price varied between roughly $1,000 and close to $4,000 per tonne.

[68] Largest non-OPEC oil exporter

Copper also started in 1980 at a price around $2,000 dollars only to reach lows of around $1,500 and highs of as much as $10,000 in mid-to-late 2000's.
Coal started around $40 per tonne, with minimums of close to $20 and highs of close to $200 and $140.
The price of these industrial commodities is subject to quite simple dynamics. Since output capacity is quite flexible within a certain range, data suggests that price variation tends to be around ±50% compared to the long-term price. This certainly seems to be generally true in the period 1980-2003. If demand goes above this range though, it seems highly likely that a lot of hedging and speculation takes place, driving the price higher than normal supply and demand would require. This makes one wonder: is it that ever greater amount of capital 'jumps' in and out of these markets? When investment opportunities are rare and capital is plenty, such moves become ever more frequent and ever stronger.
In 2003 there is a strong increase in prices of all three commodities. In the period 2003-2005 Aluminium went from around $1,500 to the $3,000 range, Copper from the $1,500 range to $8,000 in May 2006, Coal from the $25 range to $190 in summer 2008.

Interestingly, the economic or geo-political events that we were able to track and identify as reasons for periods of increased volatility do seem to consistently affect the price and volatility of these commodities.

3.4.4 Food Commodities

Chart 3.4.4.1: Commodities prices between Jan 1980 and Mar 2011, with Sugar on the right vertical axis. Horizontal axis denotes first trading day of January of the year.

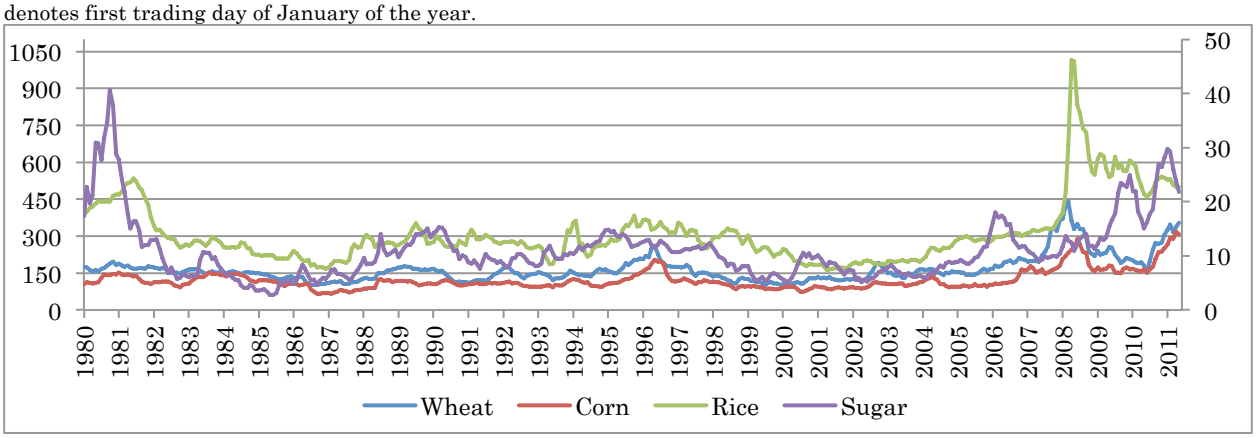
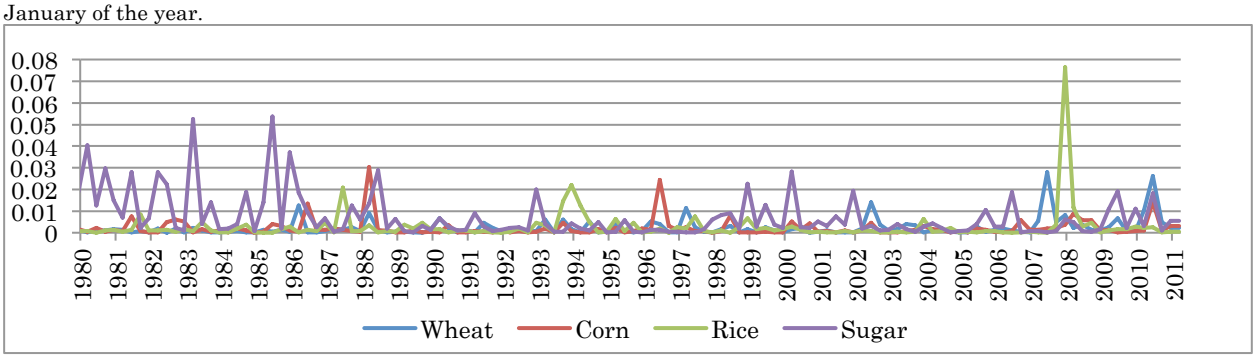


Chart 3.4.4.2: Food commodity quarterly volatilities using monthly averages. Horizontal axis denotes first trading day of January of the year.



As with industrial commodities, we see that no clear picture, as was the case of stock indexes, crude oil or gold, exists. There are however certain observations that are apparent from the graph of volatilities. First of all, these markets have volatilities several times larger than the major stock markets. It must be noted that aside from the

very high volatility of Sugar in the period of 1980-1985 and the very strong spike in Rice price volatility in the last quarter of 2007 the periods of increased volatility show a variance no larger than 0.03.

3.4.4.1 1980-1982

This was a very interesting period. I have not found explanaton for the exceptional change in the price of Sugar and Rice for this period. Wheat and Corn are stable. In this period Sugar has by far the largest volatility.

3.4.4.2 1983-2003

This period is one of relatively stable long-term prices. While prices vary quite a bit over this time, at the end of the period most of them are roughly where they started two decades earlier. And let us not forget that these prices are in nominal terms. Taking inflation into account, this means that these commodities have actually decreased in real prices.
Except Wheat, all other food commodities have had at least one great spike in volatility. Aside from these spikes, they tend to have similar magnitudes of volatility.

3.4.4.3 2003-2011

Starting in 2003 the trend is obvious, up. Sugar is one exception, as it went through a bear market in 2006 only to resume growth once more in 2007.
What is noteworthy is that 2003-2007 was period of low volatility. Only two spikes for Sugar and one for Wheat are present.
As for all other markets, 2007 and 2008 was an exceptional year.

3.5 Exchange Rates

Chart 3.5.1: Exchange rates evolution[69] Mar 1975-Mar 2011. Horizontal axis denotes first trading day of March of the year.

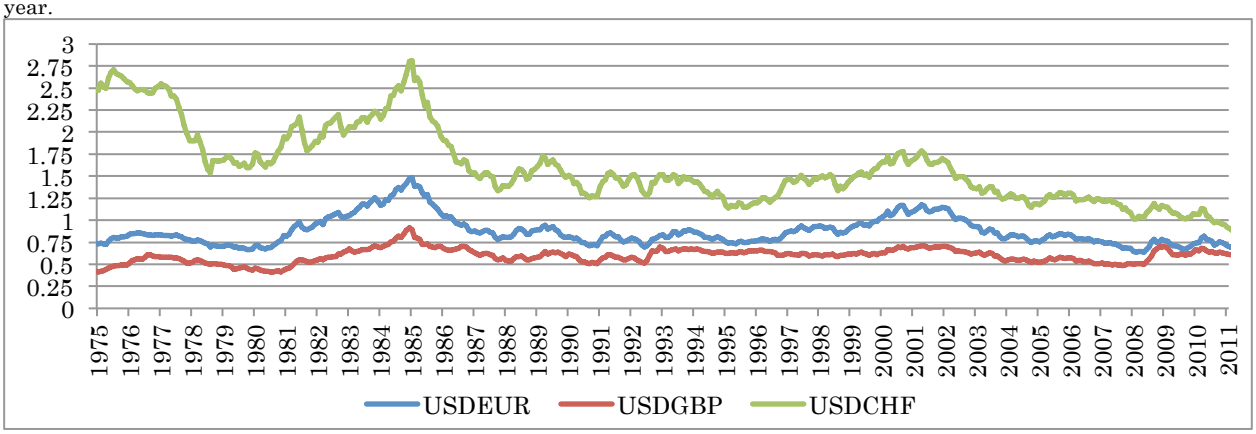
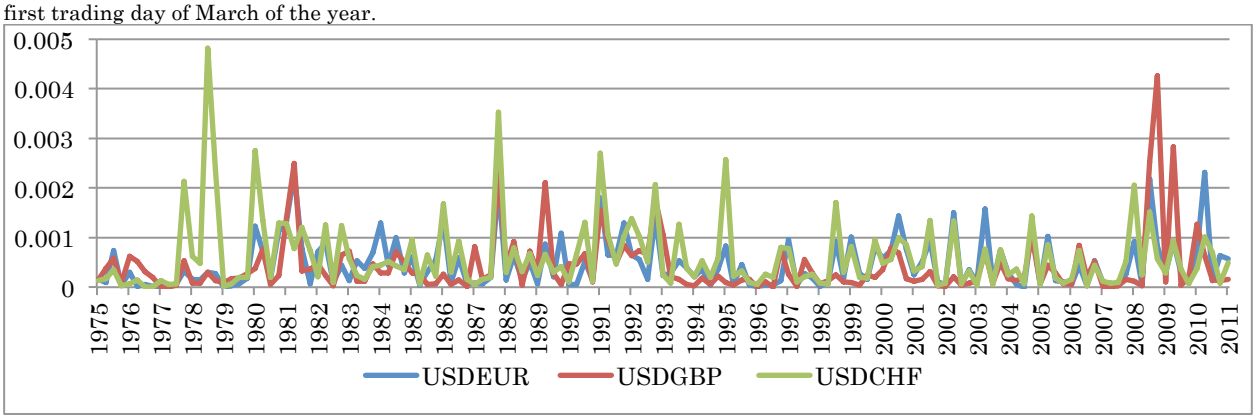


Chart 3.5.2: Exchange rate quarterly volatilities using monthly data for Mar 1975 - Mar 2011. Horizontal axis denotes first trading day of March of the year.



At first glance we see that the correlation between the three exchange rate pairs, with the exception of USDCHF in 1977-78[70] is strongly correlated. This is no coincidence. Due to its huge market volume, decentralized nature, 24 hour trading from 20:15GMT Sunday to 22:00GMT Friday, use of leverage and very high number of participants makes the international foreign exchange market probably the closest to a perfect market. About one third of the daily transaction volume is spot market transactions. The increase in this market has been exceptionally high, with daily turnover being in the magnitude of $0.5 trillion at the end of the 80's. This at a rapid pace grew to just above $1trn in 1995, $1.7trn in 1998, $1.9trn in 2004 and almost $4trn by mid-2010[71].

The close correlation can at least partially be explained by the fact that this is a market perfectly suitable for arbitrage. Arbitrage possibilities are very short-lived as many of the trades are computerized. The role and importance of speculators in this market is subject to much debate. The huge size of the market makes it much harder for any one individual or even a collusion of major participants to be able to 'corner the market'. However, especially in the past decade or so, one must ask the question: is it that the excess capital around the globe, always in search of investment possibilities, has been

[69] As mentioned earlier, pre-1999 values for USDEUR taken from dataset that rertoactively calculated values using the weights of currencies making up the Euro

[70] In this period the Swiss National Bank pursued inflationary targeting and to this day it is puszzling how far from fundamentals real exchange rates oft he Swiss franc have moved. In response, at the beginning of October 1978 Swiss authorities temporarily abandoned monetary targeting and set a floor to the Swiss franc - Deutsche mark exchange rate

[71] (Bank of International Settlements 2010) page 6

amplifying short-term moves and even trends in the exchange market. Moreover, is it that due to the size of the market and speculative activities, it has become more difficult for central banks to control the exchange rates of their currencies?
The foreign exchange market is a three-level market. At the very top are the major participants, chiefly large commercial banks and central banks. Second level is mostly other financial institutions and institutional investors such as hedge funds, whereas the third and lowest level is that available to commoners. The different levels differ very much in both volume and offered rates. The spread is smallest at the highest leve and it increases as we move downwards.

The USDCHF pair would by intuition be the most volatile, since the Swiss economy is the smallest one among the four involved economies, or economic areas (Euro). We see that this is only true up to around 1995. From then on the USDCHF volatility is of roughly the same size as the other two currency pairs and indeed shows a smaller volatility than USDEUR.

Another striking characteristic is that of the long-term devaluation of the dollar since 1985. The only exception to this trend was at the time of the 2008 crisis, when because of the 'flight to safety' into safe liquidities the dollar increased considerably in value.

Since 2008 the Swiss Franc has been revaluing very strongly against the other currencies. Explanation is quite simple. In comparison with the other economies (or currency areas), Switzerland has been less affected by the global economic downturn than the rest. Since January 2008 the Swiss currency gained about 65% on the GBP, 40-45% on the EUR and USD. The Swiss Central Bank actually had to intervene and stop the strengthening of the Swiss Franc and declare that it will do everything necessary to keep the EURUSD exchange rate above 1.2. The relationship between the USD, GBP and EUR is quite stable since the beginning of 2009. Reason is that all three economies are fraught with difficulties. The recovery has been slow or non-existent. Therefore none of the currencies shows great strength relative to the other ones.

It seems very likely that with the 2008 crisis we have entered a period of *higher volatility* than the 1992-2007 period. It is true that according to the data, the aforementioned 15 years have been exceptionally stable. As we've seen in previous analysis, when growth or recovery is slow, there is much uncertainty. This uncertainty is due to not knowing when recovery would start and how fast that recovery would be. Times of political uncertainty naturally also fuel worries in the market. Since the 2008 crash the trust in political leadership and market regulators, naturally this includes central banks as well, has greatly decreased. Their management of the situation has been less than satisfactory. The last couple of months[72] have brought further doubt as to the competence of political leaders to guide the economies back on a growth path. In America growth has been slow despite government programs aimed at stimulating growth. This is combined with an explosion in sovereign debt. The fight between Republicans and Democrats has greatly eroded international trust in American bonds. The downgrading[73] of America's sovereign debt is just further proof that recovery in America will probably take long. The chances of a Japanese-style 'lost decade' (or two) are increasing. Europe is fraught with its own sovereign debt crisis, where inconsistencies between a theoretic optimal currency area and reality are surfacing ever stronger. No ideal solution to this crisis is in sight. Chances are that Europe also faces a long period till stable economic growth will be achieved in majority of European Union

[72] This paper is written in Autumn 2011
[73] By Standard & Poors from AAA to AA+ on Aug 5, 2011.

countries. Fears regarding breakup of the Euro zone, with highly uncertain consequences for the monetary union, are still present and the longer the problem stays unresolved the more uncertain the outcome will be.

The underlying issues are very serious on both sides of the Atlantic, which means that their solutions are difficult as well. The political elite seems to have given proof for their inability to show proper leadership and tackle these problems in an appropriate manner. This is expected to continue for years to come. Thus, I would forecast that more volatile times are ahead in these markets as well.

Ch. 4
Correlations

4.1 Introduction

In the analysis of price and volatility correlations of all studied assets we are faced with difficulties that arise from the availability of data.

Analysis of how correlations between given assets have changed over time, if they did, was the most important aspect of this analysis. Both price and volatility correlations serve as the aim of this analysis.

In order to accomplish an as thorough as possible investigation I have decided to proceed the following way. First step was to look at correlations over the entire 1973-2001 period. This however is fraught with difficulty as there are only four assets for which data was available over the entire period. These are DJI, FTSE100, N225 and Gold. Shortening the time horizon by two years would have allowed me to expand the dataset to include the exchange rates as well, but I decided to aim for the 1980-2011 period instead, where I was able to calculate correlations of all analyzed assets due to availability of data. Monthly data is used.

Therefore I have calculated correlations for the maximum length period, 1973-2011 as well as the somewhat shorter 1980-2011. The decade-wise comparisons followed. I have allowed myself some liberty with regards to this comparison. In my case the decades begin with the year ending in 1 and not 0, as is customary. The first 'decade' spans only the years 1973 through 1980. Moreover, the last decade, 2001-June 2011, is actually eleven and a half years. 2010 and the first half of 2011 have been a very tumultuous time and it is my wish that the analysis contains this data. I felt that the liberties I took would not be of significant detriment to the results.

Overall, it is the decade-wise comparison that we are most interested in. We will see that there is ample difference in correlations between the different periods.

In the following standard errors and t-values of the correlations will be in parenthesis, with t-values in italics. I devote special attention to strong and moderate positive correlations. I consider everything that is ≥ 0.7 to be strongly and $0.7 \geq x \geq 0.4$ to be moderately correlated. Correlations under 0.4 are considered weak to negligible. Same rule applies to negative correlations.

Standard errors and t-values of the correlations also play an important role. In the overwhelming majority of the cases though when correlations are of at least moderate strength standard errors are low, usually under 0.03. T-values are usually above 2.7 for correlations of 0.4 and they increase rapidly for higher values. In the case of exceptions, when for instance the standard error is unusually high or the t-value shows an insignificant relationship despite the correlation being of at least moderate strength, note will be made. As for notation, standard errors and t-values will be in parenthesis and t-values in italics.
Short summaries of moderate and strong correlations, both positive and negative, will be provided at the end of every paragraph in table form.

For the sake of a achieving a most comprehensive analysis price correlations have been calculated along with volatility correlations.

4.2 Price Correlations

4.2.1 Introduction

We are faced with some limitations due to data availability. For the entire 1973-2011 period only four assets are available: the stock markets and Gold. Starting with 1980 our dataset expands to include all but one asset, the DAX. From 1990 onwards data for all assets is available. This is something we have to take into consideration when comparing the different periods.

4.2.2 1973-2011

Over the maximum period, 1973-2011, data for only four assets was available. These are, as mentioned earlier the DJI, N225, FTSE and finally Gold. The DJI-FTSE pair has by far the strongest correlation from the total of six and stands at 0.967, which is very strong. The DJI and the FTSE have a correlation of 0.49 and 0.45 respectively with Gold. The N225 has the following correlations: 0.13 with DJI; 0.30 with FTSE; 0.07 with Gold. Thus, DJI and FTSE are moderately correlated with Gold and their relationship is significant. The N225's character of being at least semi-independent from other stock markets is once more underlined by this result.
Standard errors and t-values show no abnormality.

4.2.3 1980-2011

As mentioned earlier, for the period 1980-2011 data is available for all assets but the DAX, which was introduced in 1988. Thus, instead of six correlation pairs we have hundred and five.
Of these, 24 asset pairs show strong correlation. Variances are generally very low, in the 0.001-0.004 range, and are highly significant with t-values not lower than 10.

From all stock market indexes only the DJI-FTSE pair shows strong correlation. 21 commodity pairs are strongly correlated. The last two are the USDGBP-USDEUR and USDCHF-USDEUR currency pairs. It is interesting to note that there is not a single commodity-commodity correlation that is not at least moderate.

There are a total of 40 moderate correlations with standard errors in the 0.0045-0.0067 range and t-values varying between 5.2 and 9.2. This makes all these relationships highly significant.

Stock markets show a mixed picture. The DJI and FTSE have weak to moderate positive correlations with commodities. The N225 is negatively correlated with all other assets, except Aluminum. These correlations are very weak to weak, in the -0.37 to 0.19 range. This further shows that the N225 moves very differently from other stock markets. It is the only asset that does not have a single moderate or strong correlation with any other asset. The DJI and FTSE100 are weakly to moderately positively correlated with commodities.

All commodities are at least moderately positively correlated with all other commodities. One exception is Aluminum-Rice that just missed the 0.4 threshold. Gold and Crude Oil

shows especially strong correlations with other commodities with only two correlations being moderate, the rest strong.

Exchange rates are without exception negatively correlated with all other asset classes. 17 correlation pairs are moderate, with none stronger than -0.617. The USDGBP-USDCHF pair is only moderately correlated with 0.446, the other two strongly. One could argue that this is due to the fact that the British economy is less connected to the Swiss than the other two combinations, United States-Britain and United States-Europe.
Explanation as to why exchange rates are negatively correlated with other assets is simple. The US Dollar is at the heart of world trade and most international commodities prices are denominated in this currency. A revaluation of the dollar would lead to deterioration in the terms of trade. This applies to stocks as well. Devaluation of the US Dollar will have an opposite effect.[74]
Standard errors and t-values show no abnormality.

Table 4.1

Summary			
Strong Correlations: 24		Moderate Correlations: 40	
Positive: 24	Negative: 0	Positive: 23	Negative: 17

4.2.4 1973-1980

Here we have only 6 correlation pairs between DJI, N225 and FTSE and Gold.
Surprisingly, in this period the DJI-FTSE correlation is low, standing at 0.25. This is very surprising, as this correlation tends to be among the highest in all periods.
There are only two strong correlations, N225-FTSE and N225-Gold, FTSE-Gold just missing the 0.7 threshold.
Price data shows that in this period the N225, the FTSE and Gold grew quite fast. It is towards the end of this period that Gold went through a very strong price increase. The price increase was so strong that it was only recently surpassed in real dollars.

Standard errors and t-values show no abnormality. However, on average standard errors are higher than for the much longer 1980-2011 period.

Table 4.2

Summary			
Strong Correlations: 2		Moderate Correlations: 1	
Positive: 2	Negative: 0	Positive: 1	Negative: 0

4.2.5 1981-1990

We have correlations for all but one asset, the DAX. This gives us 105 correlation pairs.

All stock market correlations are strong, with none lower than 0.933. Crude Oil is strongly negatively correlated with all stock market indices, as expected. Stock markets are positively correlated with Copper, Aluminum and Sugar and negatively with the rest. Stock market- commodity correlations are in most cases moderate,

[74] A revaluation of the dollar translates into lower exchange rates, thus smaller purchasing power in international markets. In the case of stocks a revaluation of the dollar will make purchasing American stocks more costly.

Commodities, as a group show no clear pattern. Out of a total of 42 moderate correlations 13 are between commodities, all but one positive. From the 36 commodity-commodity correlations only 7 are negative. We will see in comparison with other decades that commodities tend to be positively correlated with each other.

Exchange rates within their group show strong correlations, with the weakest at 0.705. Moreover, exchange rates are once more mostly negatively correlated with all other asset groups, however there are 7 positive exchange rate-other asset correlations. From the total of 26 exchange rate-other asset correlations 12 are moderate, 6 strong.

Table 4.3

Summary			
Strong Correlations: 15		Moderate Correlations: 42	
Positive: 9	Negative: 6	Positive: 21	Negative: 21

4.2.6 1991-2000

From here on out we work with the entire dataset, all 16 assets. This gives 120 correlations

Within the group of stock markets, the N225 once more proves itself to be an outlier of sorts. It is moderately negatively correlated with the other stock markets while all other stock markets are very strongly correlated to each other with correlations coefficients above 0.96. Another interesting observation is that all stock markets become more correlated with all other assets. Aside from the N225 all other stock markets show positive correlations with the exchange rates. This is the only decade where this observation can be made.
Strong economic and stock market growth in the USA, Britain and Germany while at the same time 'lost decade' in Japan serves as explanation for this observation. In this period, prices of commodities, especially industrial commodities, did not rise significantly despite increased demand globally. Thus, growth was not diminished by increased commodities prices.
In comparison with the previous period especially the DJI and FTSE have overall become more positively correlated with all other assets. There is a perceivable shift in correlations, especially a decrease in absolute value of the negative correlations compared to the previous period.

There is a perceivable shift within the commodities group as well. In the previous period there were 13 moderate and 2 strong positive correlations, now we have 16 moderate and 5 strong positive correlations. It is worthy of mention that in the previous period Crude Oil had sporadic positive or negative moderate correlations with the other assets. In this period it has solidly negative correlations with all other commodities. These correlations however, are weak and further characterized by standard errors around 0.025 and insignificant t-values in the ±1 range.

Among exchange rates only one correlation pair is strong: USDCHF-USDEUR. USDCHF-USDEUR and USDGBP-USDEUR are moderate. USDCHF-USDGBP shows weak correlation. This is indication of lesser interconnectedness of the British and Swiss economy.
Furthermore, correlations of exchange rates with commodities is less orderly than in the previous decade.

The USDGBP usually has weak correlations with all other assets whereas the other two exchange rates moderate or strong ones. USDEUR and USDCHF are, with the exception of Crude Oil, moderately to negatively correlated with commodities. This, as previously mentioned is what one would expect.

Table 4.4

Summary			
Strong Correlations: 21		Moderate Correlations: 44	
Positive: 13	Negative: 8	Positive: 23	Negative: 21

4.2.7 2001-June 2011

On first sight it is obvious that correlations have changed tremendously in this decade. They have grown across the board.

All stock markets have on average become considerably more correlated with commodities. Stock markets and exchange rates are once more negatively correlated, albeit only moderately. N225 is once more the odd-one-out among the stock markets. It shows the least correlation with all other markets. The N225-DAX correlation is the only one from within the exchange rate group that does not show strong correlation, only moderate. N225's negative correlations have decreased in absolute value, thus becoming more correlated. DJI, FTSE, DAX have almost exclusively positive correlations with commodities. These are moderate to strong. Negative correlations are usually in the vicinity of zero.
Stock markets are negatively correlated with exchange rates. There are 4 moderate correlations, with two being around 0.65, thus really close to the 'strong' threshold. There are no strong correlations, though.

All commodities are positively correlated within their group. All correlations are at least moderate. There are 12 moderate correlations within the group of commodities, to be exact. What is astonishing though is that from the total of 36 commodity-commodity correlations 24 are strong. This relationships pertains to virtually all commodities, no significant distinction can be made in the correlations of food and industrial commodities.
Moreover, commodities have solidly negative correlations with exchange rates.

Exchange rates, as mentioned earlier have negative correlations with all other assets across the board. Once more, USDGBP shows smaller magnitude correlations than the other two exchange rate pairs with commodities.

Table 4.5

Summary			
Strong Correlations: 21		Moderate Correlations: 45	
Positive: 12	Negative: 9	Positive: 27	Negative: 18

4.3 Volatility Correlations

4.3.1 Introduction

We are faced with the same limitations due to the data as in section 4.2 – Price volatilities. Standard errors and t-values for the correlations are virtually identical to those of price volatilities. In almost all instances standard errors are not larger than 0.03 and in the overwhelming majority of cases half or even on fifth of that. As for t-values, they are far into significant territory even for moderate correlations.

4.3.2 1973-2011

We have the same four assets as in the analogous section of price volatilities: DJI, FTSE, N225, Gold. Of the six correlations only the DJI-N225 and DJI-FTSE correlations are moderate and even these two just barely making it above 0.4. Gold has near zero correlation with the stock markets. Having seen the evolution of the price of Gold over this time horizon we see that indeed this commodity has had vastly different relationship with the stock markets. It had a great increase in price in 1979-1980 only to go through a twenty-year bear market and then to increase vastly in price once more starting in the first few years of the 21st century. In the meantime the stock markets had their usual ups and downs.

Standard errors and t-values show no irregularity. Albeit, correlations of around ±0.2 already have t-values above 2.5, making them significant at

4.3.3 1980-2011

Other than the DAX we have data for this period, thus 15 assets and 105 correlations. The picture for volatility correlations is very different from that of price volatilities. We have a total of 1 strong correlation, USDEUR-USDCHF, and 7 moderate correlations. Three of the moderate correlations are those of stock markets with each other and two more are exchange rate-exchange rate correlations.

Very interesting is not merely the fact that there are very few moderate correlations but that the rest are generally very close to zero, usually in the ±0.1 range.

Stock markets have virtually zero correlation with both commodities and exchange rates.

Commodities show somewhat more correlation within their group. Most of these correlations are positive.

Table 4.6

Summary			
Strong Correlations: 1		Moderate Correlations: 7	
Positive: 1	Negative: 0	Positive: 7	Negative: 0

4.3.4 1973-1980

Just like in section 4.3.1 we have only four assets. The only moderate correlation is DJI-FTSE. There are no strong correlations. Gold is positively correlated with DJI and

negatively with the other two stock markets. Stock markets are positively correlated with each other.

Table 4.7

Summary			
Strong Correlations: 0		Moderate Correlations: 1	
Positive: 0	Negative: 0	Positive: 1	Negative: 0

4.3.5 1981-1990

After having done the analysis of price correlations we were pampered, so to speak, to see certain patterns in correlations. Even though we have 105 correlations pairs of 15 assets for this period, no clear patter emerges. There is only one strong correlation, with three more around 0.65, barely missing the threshold. Surprisingly few moderate correlations as well, a total of 7, all positive.

Stock markets have the only one strong correlation, not surprising the DJI-FTSE, as well as two moderate ones. Correlations with commodities are weak for all indexes, none being outside the ±0.24 range. Almost all have standard error of about 0.26. All t-values are insignificant. Situation of stock market-commodities correlations paints a similar picture, correlations here are even closer to zero. Stock market-other asset correlations are about evenly split between positive and negative.

Commodities show two moderate relationships, standing at 0.575 and 0.594 respectively. There is one more correlation that is relatively close to being moderate, standing at 0.35. All others within the ±0.24 range, with most being in the ±0.1 range. Once more, ratio of positive and negative correlations is roughly half-half.
Commodity-exchange rate correlations follow in much the same way. Here however, there are considerably more negative correlations than positive ones. It is interesting to note that only correlations of three commodities have the same sign with all three exchange rates. The variation of these correlations is about as narrow as the rest of the field, with one correlation standing at 0.26 while most others are in the ±15 range, many even ±0.1.
Interestingly, the standard errors are once more almost always 0.26. Aside the moderate strength correlations none of the t-values of commodities-other asset correlations are significant.

Table 4.8

Summary			
Strong Correlations: 1		Moderate Correlations: 7	
Positive: 1	Negative: 0	Positive: 7	Negative: 0

4.3.6 1991-2000

From this period onwards we work with all 16 assets and correspondingly 120 correlations.
Already on first sight we see that there is a wider variation of correlation values. We now have 3 strong and 5 moderate correlations. The most striking is that most of the other correlations have increased in absolute value.

Out of the 6 stock market-stock market correlations 2 are strong, DJI-FTSE, DJI-DAX, 3 are moderate, DJI-N225, N225-FTSE and FTSE-DAX, with the last one jus barely

missing the threshold to strong with 0.693. The last correlation from the six also just missed the moderate threshold with 0.369.
Correlations with commodities have changed in character. They tend to be on average higher in absolute value. Number of positive correlations in this group is now considerably larger than the negative ones, the ratio is roughly 2:1. Standard errors are around 0.025. None of the t-values in this group are significant. In comparison with other periods, t-values for roughly the same correlations are considerably weaker.
Stock market-exchange rate correlations show no particularity. One noteworthy characteristic however is that they are negative with the exception of N225-exchange rate correlations. Along with N225-other stock market correlations this once more underlines that the N225 simply walks a path considerably different from other stock markets.

Stock market correlations, a total of 36 to be exact, contain only one moderate correlation. The ratio of positive to negative has changed here as well from being roughly equal to 2:1 in favor of negative correlations. In comparison with the other non-commodity correlations it is rather a shift towards more positive values that we witness within this group.
Commodity-exchange rate correlations show a similar pattern as the previous period, with the same shift towards positive values as commodities-commodities correlations.

Exchange rates show 1 strong and 2 moderate correlations within their group. As mentioned earlier with the exception of N225 they are negatively correlated with stock markets. In the case of 7 out of 9 commodities exchange rate-commodity correlations have the same sign for all three exchange rates.

Table 4.9

Summary			
Strong Correlations: 3		Moderate Correlations: 5	
Positive: 3	Negative: 0	Positive: 5	Negative: 0

4.3.7 2001-2011

Once more we work with all 16 assets and 120 correlation pairs.
The picture is quite different from previous periods. We now have 6 strong and 16 moderate correlations. All positive.

Stock markets have 2 strong correlations, same as before DJI-FTSE and DJI-DAX, and 2 moderate ones, once more N225-FTSE and FTSE-DAX, with the latter just missing the threshold for strong with a value of 0.651. The DJI-N225 correlation just missed the threshold for moderate correlation with a value of 0.346.
All the stock market-commodity correlations are weak, the highest correlation being -0.22. Moreover, ratio of positive to negative correlations leans somewhat towards the negative.
Stock market-exchange rate correlations have changed compared to the previous period. With the exception of N225 all other stock markets have become more correlated with exchange rates.

Commodities have become significantly more correlated with each other as well. There are 2 strong and 6 moderate commodity-commodity correlations. What is even more important is that out of the 36 correlation pairs only 7 are negative.

Moreover there is 1 strong and 7 moderate commodity-exchange rate correlations out of 27. Here as well, correlations have shifted strongly in the positive direction.

Exchange rate as mentioned earlier show increased correlation with stock markets and now we have only 4 negative correlations out of 12. Exchange rate-commodity correlations have been analyzed in the previous paragraph.
What is worthy of mention is that now we have 1 strong, USDCHF-USDEUR, correlation and 1 moderate, USDGBP-USDEUR. USDCHF-USDGBP is once more weak, missing the moderate threshold, at 0.362.

Table 4.10

Summary			
Strong Correlations: 6		Moderate Correlations: 16	
Positive: 6	Negative: 0	Positive: 16	Negative: 0

4.4 Comparison of Different Periods

Our attention shifts to *quantifying* the changes in correlations over the different periods. For both price and volatility correlations I will focus on the three full decades where we have data for 15 and 16 decades respectively. My analysis will always bear in mind that the DAX is only available for the last two decades. Therefore I will always sterilize my numeric results from DAX correlations so that I do not fall in the trap of comparing apples and pears.
Analysis of price and volatility correlations will run parallel.

The average correlation of all markets, while a crude measurement expressed with a single value, still provides information of the overall state of things. Along with this one value I will also provide numeric values for the different correlations both within and between groups, i.e.: stock markets-stock market, commodities-exchange rates, etc. Tables, just as in the previous section, will facilitate keeping track of all the values.

Before we start, a bit of extra information to keep in mind, the number of intra- and intergroup correlation pairs: stock market-stock market 9; stock market-commodity 27; stock market-exchange rates 9; commodity-commodity 36; commodity-exchange rate 27; exchange rate-exchange rate 3. This gives 105 correlation pairs for 15 assets. As mentioned earlier, the DAX had to be removed from the quantitative analysis, as it would have made comparison of 1981-1990 with subsequent periods impossible.

4.4.1 1981-1990

When interpreting the group correlations sums, please bear in mind that there are great differences in the number of correlations that actually give these sums. In order to incorporate that information I have added 'Average' in the tables. This is the value of the sum divided by the number of correlation pairs that give the sum.

Price Correlations

Table 4.11

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	2.857	0.952	-	-	-	-
Comm.	-2.024	-0.075	8.649	0.24	-	-
E. Rates	-4.155	-0.466	-6.241	-0.231	2.515	0.838
Total Sum: 1.602						

All asset groups have positive correlations within themselves means that it must be the correlations between assets of different groups that must be negative. And so it is.
It is worthy to note that summing all 105 correlation pairs gives a positive number. This would lead us to conclude that there is some positive correlation. Dividing this value with the number of correlations we get 0.0152. This is the value with which every correlation pair, on average, contributes to across the board correlation.

When looking at the average contributions of the correlation pairs in the various groups, we see great differences. The range varies from 0.952 in the case of intra-group stock markets to -0.466 in the case of stock markets-exchange rates.

Volatility Correlations
Table 4.12

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	1.7998	0.5999	-	-	-	-
Comm.	-0.1746	-0.0065	1.7266	0.0480	-	-
E. Rates	-0.0691	-0.0077	-0.7137	-0.0264	1.8729	0.6243
Total Sum	4.4419					

For the same period, with respects to volatility we get a similar picture. Assets within the same group are on average positively correlated, as one would expect. Here every correlation pair contributes, on average, with 0.042 to the sum total of correlations.

It is interesting to note that all of the intra-group correlations are smaller than the price correlations for the same groups. Yet the sum is much larger. Explanation is that indeed the average contribution is very close to zero for all inter-group correlation pairs. Variation of average contributions is considerably smaller than in the case of price correlations, standing between 0.624 and -0.026.

4.4.2 1991-2000

Price Correlations
Table 4.13

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	0.0365	0.0122	-	-	-	-
Comm.	-4.2287	-0.1566	14.0178	0.3894	-	-
E. Rates	2.4441	0.2716	-7.9619	-0.2949	1.4415	0.4805
Total Sum	5.7493					

Picture is similar to that of last period. Intra-group correlation sums are positive once again. The stock markets-exchange rates correlation sum is also positive.

Change in Price Correlations
Table 4.13

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	-2.8200	-0.9400	-	-	-	-
Comm.	-2.2052	-0.0817	5.3688	0.1491	-	-
E. Rates	6.5991	0.7332	-1.7213	-0.0638	-1.0737	-0.3579
Total Sum	4.1477					

It is most of all the changes in correlations that we are interested in. By observing the table we see what these changes are.
Some have soared, such as stock markets-exchange rates and intra-group commodities, other have fallen and fallen very strongly, intra-group stock markets. Stock markets have become much less correlated, practically not correlated at all. This can mostly be attributed to the N225 dropping precipitously in this period while other stock markets soared especially towards the end of the period. The increase in the stock markets-exchange rates sum is also very strong. In fact it is this group that had the largest average increase. Intra-group commodities also weigh in, however mostly due to the large number of correlation pairs, 36.

Volatility Correlations
Table 4.14

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	1.6372	0.5457	-	-	-	-
Comm.	1.8352	0.0680	0.0627	0.0017	-	-
E. Rates	-0.4831	-0.0537	-0.6427	-0.0238	1.9785	0.6595
Total Sum	4.3878					

Intra-group sums are once more positive, however the low value of commodities is quite surprising. The positive correlations, which wasn't too strong in the first place is almost completely gone. Intra-group stock market and exchange rate averages are still going strong in this period.

Change in Volatility Correlations
Table 4.15

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	-0.1626	-0.0542	-	-	-	-
Comm.	2.0098	0.0744	-1.6639	-0.0462	-	-
E. Rates	-0.4139	-0.0460	0.0710	0.0026	0.1056	0.0352
Total Sum	-0.0541					

The changes are quite interesting, due to the fact that practically all of them are very small and their sum is a mere -0.0541. This means practically no change over the previous period.

4.4.3 2001-2011

Price Correlations
Table 4.16

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	2.4490	0.8163	-	-	-	-
Comm.	9.5430	0.3534	26.9311	0.7481	-	-
E. Rates	-3.2052	-0.3561	-15.3133	-0.5672	2.0634	0.6878
Total Sum	22.4679					

This period shows very strong intra-group average correlation for all three asset groups. The negative sums and averages of exchange rates with the other two groups is what

theory would suggest is the norm. However, the previous period failed to produce this result for the stock markets-exchange rates relationship.
We can conclude that across the board correlations are either strong or moderate. It is true that stock markets-commodities with its 0.35 and stock markets-exchange rates with its -0.35 fall short of the threshold set for moderate but they are undeniably close. This strength of relationships across the board was not observed at any previous period.

Change in Price Correlations
Table 4.17

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	2.4124	0.8041	-	-	-	-
Comm.	13.7717	0.5101	12.9133	0.3587	-	-
E. Rates	-5.6492	-0.6277	-7.3514	-0.2723	0.6219	0.2073
Total Sum	16.7187					

These are our main results at a glance. The last decade has produced vastly more correlated markets. Over 3 decades we went from an average correlation for all 15 assets of 0.0152 to 0.1592. Correlations where exchange rates are not present have increase especially strongly. What I find especially striking is that commodities are on average more correlated with stock markets than with other commodities markets when it comes to prices.
A last word on interpreting exchange rates will follow in the conclusions.

Volatility Correlations
Table 4.18

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	1.5390	0.5130	-	-	-	-
Comm.	0.4474	0.0166	7.1364	0.1982	-	-
E. Rates	0.6448	0.0716	7.2924	0.2701	1.6143	0.5381
Total Sum	18.6742					

We have across the board positive correlation of volatilities for this decade. It is something we weren't able to observe at any previous time. A strong positive relationship between stock markets is expected. A strong positive relationship between exchange rates is expected as well. However, they do not seem to be that strong for this period. The 2001-2011 period was quite tumultuous to say the least. It began with the aftermath of the bursting of the Dot Com Bubble, then strong growth in 2003-2007 only to be followed by the most severe economic crisis since the Great Depression, followed by a market upswing once more since early 2009 only to be halted once more in 2010. The strategically different starting points of the various economies represented by their stock markets as well as the responses to these various trends explain the relative weakness of the intra-group stock market correlations. Same can be said about exchange rates. Differing monetary policies in different countries achieves lower exchange rate correlation over longer periods of time.

Change in Volatility Correlations

Table 4.19

	Stock Markets		Commodities		Exchange Rates	
	Sum	Average	Sum	Average	Sum	Average
S. Markets	-0.0982	-0.0327	-	-	-	-
Comm.	-1.3878	-0.0514	7.0737	0.1965	-	-
E. Rates	1.1279	0.1253	7.9351	0.2939	-0.3642	-0.1214
Total Sum	14.2864					

We see an interesting array of changes compared to the previous period. Intra-group stock market, stock markets-commodities correlations have changed little. It is interesting to note that stock markets-exchange rates correlations have, on average, increased by almost the same amount as intra-group exchange rates have declines. Commodities have become once more somewhat correlated with other commodities. The increase in correlation between exchange rates and correlations is somewhat of a surprise.

4.5 Conclusions on Correlations

A little caveat on exchange rates price correlations with other assets before we conclude. As mentioned earlier the negative correlations of exchange rates with other assets is what we would expect.[75] In this sense, the fact that price correlations of exchange rates with other assets have become more negative further underlines the fact that markets move together stronger than before. The crude method of adding up all correlations to see if indeed it can be said that a general increase in correlations has happened, which would be expressed in a higher number, is naturally hurt by the increase in negative price correlations of exchange rates with other assets. Since this increase in negative correlations expresses a stronger correlation with the markets we could, for this group of assets, remove the sign of the correlations. If we were to do that, our results for adding up all correlation values would point to an even stronger increase in correlations for the last decade. The main result is as follows.

The main finding of this analysis is that markets have become more correlated over the last decade. Over the longer term there is considerable and significant fluctuation between market correlations.

Because not only prices but volatilities as well have become more correlated this means that both booms and busts are not only more rapidly but also more strongly transmitted. The current economic crisis, The Great Recession, is proof of that. This also means that individual efforts to stimulate economies prove to be more and more difficult. Quantitative easing from the Fed and the European Central Bank are proof for that. The world has become more interconnected, there is little doubt about that. But there also seems little doubt about the fact that trouble in any of the core regions, such as the USA, Europe and as of late China, will be transmitted much more strongly to other regions. This state of affairs constitutes a break from the past. What has worked in the past may no longer be applicable. The 'rules of the game' are changed without anyone really understanding what those rules really are. The new guiding dynamic, unbeknownst to market participants and regulators alike, can easily result in more uncertainty and significantly more volatile markets.

[75] Cheaper currency makes exports more competitive which is an advantage to the firms and moreover stock prices become more attractive for foreign investors. As commodities are denominated in dollars in the international markets a devaluation of the dollar relative to some other currency makes commodities cheaper for buyers who hold that currency.

Final Remarks &Conclusions

I have shown that the nature of how markets are connected has been changing and it points towards a certain increase in correlations. This has far reaching consequences. It would seem that the globalization of financial and commodities markets has not made the world market as a whole more stable. On the contrary, economies are much more dependent on each other than ever before.

This is the new economic reality of our time that brings new difficulties to international cooperation in areas ranging from trade, capital flows and on a political level to monetary and even fiscal policy. It is a world where no country, not even super-powers and the three pillars of the world economy consisting of the USA, Europe and China can pursue fully independent policies without causing harm or benefitting the rest.

"We are all in it together and our fortune will rise or fall together…"[76]

[76] Chrstine Lagarde, head of IMF in (The Telegraph 2011).

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List of Charts

Appendix

In the following some of the most important datasets and results tables will be presented. Quarterly volatilities using monthly data first, then price and volatility correlations.

[77] As mentioned earlier, pre-1999 values for USDEUR taken from dataset that rertoactively calculated values using the weights of currencies making up the Euro

	^DJI	^N225	^FTSE	^DAX	Gold	USDEUR	USDGBP	USDCHF
Mar-11	0.00048	0.00007	0.00033	0.00030	0.00065	0.00057	0.00016	0.00050
Dec-10	0.00034	0.00182	0.00013	0.00030	0.00032	0.00064	0.00014	0.00009
Sep-10	0.00073	0.00292	0.00108	0.00057	0.00107	0.00013	0.00015	0.00070
Jun-10	0.00139	0.00163	0.00111	0.00066	0.00129	0.00231	0.00064	0.00100
Mar-10	0.00379	0.00759	0.00374	0.00027	0.00011	0.00071	0.00127	0.00038
Dec-09	0.00149	0.00263	0.00213	0.00301	0.00192	0.00013	0.00018	0.00007
Sep-09	0.00148	0.00365	0.00126	0.00233	0.00114	0.00029	0.00005	0.00037
Jun-09	0.00083	0.00031	0.00291	0.00100	0.00099	0.00092	0.00282	0.00093
Mar-09	0.00045	0.00365	0.00053	0.00034	0.00235	0.00028	0.00011	0.00028
Dec-08	0.00389	0.00130	0.00171	0.00366	0.00159	0.00083	0.00426	0.00057
Sep-08	0.00114	0.00046	0.00028	0.00110	0.00495	0.00219	0.00252	0.00151
Jun-08	0.00103	0.00829	0.00500	0.00331	0.00016	0.00005	0.00002	0.00025
Mar-08	0.00427	0.00096	0.00189	0.00274	0.00183	0.00092	0.00011	0.00206
Dec-07	0.00032	0.00219	0.00032	0.00058	0.00135	0.00026	0.00016	0.00052
Sep-07	0.00070	0.00217	0.00060	0.00017	0.00161	0.00011	0.00003	0.00009
Jun-07	0.00071	0.00042	0.00017	0.00037	0.00032	0.00002	0.00000	0.00009
Mar-07	0.00045	0.00044	0.00021	0.00165	0.00070	0.00009	0.00001	0.00012
Dec-06	0.00022	0.00009	0.00013	0.00022	0.00162	0.00054	0.00052	0.00044
Sep-06	0.00025	0.00097	0.00020	0.00078	0.00106	0.00003	0.00020	0.00003
Jun-06	0.00047	0.00060	0.00002	0.00076	0.00452	0.00044	0.00085	0.00074
Mar-06	0.00011	0.00264	0.00067	0.00103	0.00005	0.00006	0.00006	0.00015
Dec-05	0.00012	0.00066	0.00036	0.00065	0.00196	0.00011	0.00007	0.00008
Sep-05	0.00032	0.00710	0.00079	0.00215	0.00130	0.00013	0.00028	0.00019
Jun-05	0.00006	0.00461	0.00041	0.00051	0.00012	0.00102	0.00044	0.00086
Mar-05	0.00019	0.00065	0.00099	0.00217	0.00021	0.00006	0.00007	0.00006
Dec-04	0.00022	0.00026	0.00014	0.00016	0.00074	0.00120	0.00105	0.00144
Sep-04	0.00132	0.00120	0.00041	0.00130	0.00008	0.00001	0.00020	0.00007
Jun-04	0.00002	0.00051	0.00033	0.00027	0.00062	0.00005	0.00013	0.00036
Mar-04	0.00017	0.00083	0.00004	0.00027	0.00013	0.00028	0.00017	0.00024
Dec-03	0.00012	0.00185	0.00018	0.00072	0.00122	0.00076	0.00050	0.00075
Sep-03	0.00146	0.00085	0.00050	0.00176	0.00155	0.00009	0.00008	0.00006
Jun-03	0.00011	0.00174	0.00009	0.00151	0.00215	0.00158	0.00071	0.00077
Mar-03	0.00089	0.00550	0.00027	0.00244	0.00082	0.00009	0.00012	0.00005
Dec-02	0.00011	0.00071	0.00015	0.00404	0.00065	0.00035	0.00008	0.00033
Sep-02	0.00128	0.00159	0.00080	0.00477	0.00021	0.00006	0.00004	0.00007
Jun-02	0.00592	0.00066	0.00535	0.02544	0.00090	0.00149	0.00021	0.00133
Mar-02	0.00170	0.00279	0.00303	0.00498	0.00070	0.00005	0.00001	0.00008
Dec-01	0.00058	0.00239	0.00028	0.00135	0.00021	0.00011	0.00003	0.00005
Sep-01	0.00273	0.00025	0.00037	0.00399	0.00088	0.00093	0.00031	0.00135
Jun-01	0.00759	0.00939	0.00374	0.02315	0.00055	0.00051	0.00016	0.00042
Mar-01	0.00037	0.00137	0.00078	0.00029	0.00005	0.00024	0.00012	0.00032
Dec-00	0.00238	0.00157	0.00313	0.00600	0.00011	0.00076	0.00017	0.00085
Sep-00	0.00070	0.00108	0.00060	0.00347	0.00025	0.00144	0.00069	0.00099
Jun-00	0.00117	0.00162	0.00097	0.00119	0.00036	0.00073	0.00079	0.00056
Mar-00	0.00020	0.00234	0.00001	0.00140	0.00085	0.00058	0.00036	0.00049
Dec-99	0.00189	0.00040	0.00070	0.00381	0.00224	0.00080	0.00020	0.00095
Sep-99	0.00136	0.00073	0.00262	0.01473	0.00035	0.00015	0.00025	0.00018
Jun-99	0.00055	0.00015	0.00039	0.00028	0.00161	0.00027	0.00004	0.00019
Mar-99	0.00037	0.00180	0.00070	0.00120	0.00001	0.00100	0.00009	0.00081
Dec-98	0.00077	0.00298	0.00112	0.00093	0.00005	0.00018	0.00011	0.00030
Sep-98	0.00130	0.00243	0.00160	0.00162	0.00023	0.00091	0.00025	0.00170
Jun-98	0.00760	0.01128	0.00561	0.02062	0.00071	0.00011	0.00013	0.00007

	^DJI	^N225	^FTSE	^DAX	Gold	USDEUR	USDGBP	USDCHF
Mar-98	0.00009	0.00004	0.00007	0.00516	0.00023	0.00002	0.00007	0.00008
Dec-97	0.00299	0.00009	0.00177	0.00485	0.00342	0.00018	0.00029	0.00026
Sep-97	0.00103	0.00215	0.00122	0.00350	0.00000	0.00027	0.00056	0.00021
Jun-97	0.00143	0.00494	0.00203	0.00341	0.00004	0.00004	0.00002	0.00011
Mar-97	0.00205	0.00136	0.00051	0.00214	0.00010	0.00096	0.00026	0.00078
Dec-96	0.00052	0.00023	0.00002	0.00372	0.00028	0.00014	0.00077	0.00081
Sep-96	0.00176	0.00173	0.00030	0.00190	0.00004	0.00005	0.00001	0.00019
Jun-96	0.00105	0.00114	0.00110	0.00124	0.00012	0.00005	0.00010	0.00026
Mar-96	0.00007	0.00020	0.00021	0.00013	0.00011	0.00001	0.00001	0.00006
Dec-95	0.00031	0.00095	0.00006	0.00001	0.00003	0.00004	0.00015	0.00009
Sep-95	0.00157	0.00348	0.00056	0.00044	0.00002	0.00045	0.00015	0.00032
Jun-95	0.00036	0.00196	0.00004	0.00014	0.00006	0.00005	0.00004	0.00022
Mar-95	0.00071	0.00547	0.00031	0.00041	0.00006	0.00083	0.00010	0.00256
Dec-94	0.00154	0.00540	0.00069	0.00199	0.00018	0.00036	0.00022	0.00058
Sep-94	0.00049	0.00058	0.00003	0.00020	0.00022	0.00004	0.00006	0.00019
Jun-94	0.00038	0.00080	0.00141	0.00233	0.00012	0.00036	0.00019	0.00053
Mar-94	0.00033	0.00100	0.00127	0.00268	0.00004	0.00020	0.00003	0.00021
Dec-93	0.00203	0.00089	0.00381	0.00041	0.00066	0.00039	0.00006	0.00037
Sep-93	0.00013	0.00896	0.00196	0.00304	0.00259	0.00053	0.00015	0.00126
Jun-93	0.00029	0.00053	0.00085	0.00157	0.00204	0.00028	0.00020	0.00008
Mar-93	0.00025	0.00114	0.00024	0.00057	0.00000	0.00023	0.00106	0.00025
Dec-92	0.00034	0.00279	0.00018	0.00155	0.00025	0.00142	0.00177	0.00207
Sep-92	0.00018	0.00082	0.00119	0.00039	0.00025	0.00015	0.00066	0.00051
Jun-92	0.00051	0.00414	0.00253	0.00234	0.00003	0.00056	0.00074	0.00103
Mar-92	0.00014	0.00490	0.00133	0.00041	0.00027	0.00064	0.00064	0.00138
Dec-91	0.00005	0.00443	0.00084	0.00028	0.00001	0.00130	0.00085	0.00102
Sep-91	0.00208	0.00344	0.00086	0.00003	0.00070	0.00064	0.00050	0.00047
Jun-91	0.00002	0.00173	0.00012	0.00018	0.00022	0.00065	0.00096	0.00106
Mar-91	0.00066	0.00379	0.00034	0.00103	0.00092	0.00179	0.00155	0.00270
Dec-90	0.00111	0.00486	0.00403	0.00192	0.00003	0.00014	0.00010	0.00012
Sep-90	0.00144	0.00330	0.00069	0.33356	0.00203	0.00052	0.00068	0.00131
Jun-90	0.00745	0.03737	0.00605		0.00100	0.00006	0.00046	0.00066
Mar-90	0.00209	0.00327	0.00428		0.00097	0.00005	0.00047	0.00010
Dec-89	0.00051	0.01159	0.00047		0.00303	0.00109	0.00006	0.00041
Sep-89	0.00040	0.00204	0.00377		0.00034	0.00020	0.00028	0.00030
Jun-89	0.00020	0.00030	0.00050		0.00056	0.00087	0.00211	0.00067
Mar-89	0.00016	0.00039	0.00009		0.00048	0.00006	0.00031	0.00023
Dec-88	0.00034	0.00040	0.00033		0.00031	0.00051	0.00072	0.00068
Sep-88	0.00016	0.00149	0.00036		0.00097	0.00014	0.00004	0.00031
Jun-88	0.00062	0.00013	0.00082		0.00000	0.00064	0.00092	0.00078
Mar-88	0.00094	0.00005	0.00044		0.00180	0.00014	0.00043	0.00030
Dec-87	0.00086	0.00282	0.00019		0.00059	0.00205	0.00242	0.00353
Sep-87	0.00179	0.00090	0.00282		0.00014	0.00019	0.00024	0.00019
Jun-87	0.00033	0.00120	0.00080		0.00053	0.00006	0.00016	0.00016
Mar-87	0.00103	0.00098	0.00296		0.00012	0.00008	0.00081	0.00005
Dec-86	0.00109	0.00146	0.00293		0.00178	0.00006	0.00002	0.00016
Sep-86	0.00009	0.00288	0.00025		0.00835	0.00059	0.00015	0.00093
Jun-86	0.00164	0.00142	0.00143		0.00001	0.00009	0.00005	0.00030
Mar-86	0.00101	0.00298	0.00035		0.00014	0.00134	0.00027	0.00168
Dec-85	0.00533	0.01107	0.00570		0.00005	0.00055	0.00007	0.00022
Sep-85	0.00348	0.00015	0.00049		0.00037	0.00031	0.00005	0.00065
Jun-85	0.00005	0.00042	0.00096		0.00024	0.00004	0.00026	0.00006

	^DJI	^N225	^FTSE	^DAX	Gold	USDEUR	USDGBP	USDCHF
Mar-85	0.00095	0.00036	0.00099		0.00011	0.00061	0.00028	0.00095
Dec-84	0.00007	0.00059	0.00007		0.00132	0.00029	0.00050	0.00036
Sep-84	0.00010	0.00016	0.00113		0.00011	0.00100	0.00072	0.00043
Jun-84	0.00245	0.00118	0.00383		0.00003	0.00044	0.00029	0.00052
Mar-84	0.00085	0.00251	0.00370		0.00096	0.00129	0.00029	0.00044
Dec-83	0.00090	0.00212	0.00119		0.00021	0.00070	0.00047	0.00041
Sep-83	0.00042	0.00114	0.00148		0.00019	0.00037	0.00012	0.00016
Jun-83	0.00019	0.00039	0.00022		0.00093	0.00053	0.00012	0.00024
Mar-83	0.00013	0.00023	0.00027		0.00675	0.00013	0.00073	0.00058
Dec-82	0.00063	0.00073	0.00016		0.00126	0.00044	0.00064	0.00124
Sep-82	0.00084	0.00249	0.00017		0.01755	0.00010	0.00004	0.00009
Jun-82	0.00360	0.00042	0.00204		0.00290	0.00090	0.00024	0.00125
Mar-82	0.00054	0.00015	0.00053		0.00637	0.00072	0.00047	0.00021
Dec-81	0.00107	0.00217	0.00065		0.00129	0.00006	0.00037	0.00073
Sep-81	0.00044	0.00015	0.00291		0.00222	0.00078	0.00032	0.00121
Jun-81	0.00343	0.00076	0.00848		0.00141	0.00229	0.00249	0.00078
Mar-81	0.00012	0.00041	0.00069		0.00394	0.00134	0.00140	0.00128
Dec-80	0.00084	0.00017	0.00065		0.00283	0.00114	0.00024	0.00129
Sep-80	0.00129	0.00001	0.00087		0.00139	0.00018	0.00006	0.00020
Jun-80	0.00000	0.00035	0.00042		0.00845	0.00073	0.00076	0.00135
Mar-80	0.00094	0.00000	0.00319		0.01228	0.00123	0.00037	0.00275
Dec-79	0.00336	0.00033	0.00231		0.00798	0.00018	0.00028	0.00020
Sep-79	0.00021	0.00012	0.00028		0.01167	0.00006	0.00019	0.00020
Jun-79	0.00062	0.00046	0.00129		0.00594	0.00002	0.00017	0.00007
Mar-79	0.00038	0.00002	0.00398		0.00171	0.00001	0.00009	0.00001
Dec-78	0.00102	0.00013	0.00944		0.00329	0.00028	0.00014	0.00236
Sep-78	0.00006	0.00007	0.00013		0.00349	0.00030	0.00030	0.00482
Jun-78	0.00008	0.00038	0.00010		0.00071	0.00015	0.00008	0.00048
Mar-78	0.00020	0.00005	0.00043		0.00084	0.00016	0.00008	0.00063
Dec-77	0.00034	0.00106	0.00109		0.00009	0.00033	0.00053	0.00213
Sep-77	0.00007	0.00048	0.00071		0.00051	0.00007	0.00004	0.00007
Jun-77	0.00064	0.00138	0.00740		0.00088	0.00000	0.00000	0.00006
Mar-77	0.00024	0.00016	0.00072		0.00363	0.00000	0.00000	0.00013
Dec-76	0.00035	0.00014	0.00133		0.00556	0.00002	0.00020	0.00000
Sep-76	0.00091	0.00275	0.01698		0.00117	0.00006	0.00032	0.00001
Jun-76	0.00007	0.00034	0.00372		0.00008	0.00002	0.00052	0.00015
Mar-76	0.00021	0.00056	0.00281		0.00003	0.00030	0.00062	0.00007
Dec-75	0.00023	0.00009	0.00038		0.00017	0.00005	0.00008	0.00003
Sep-75	0.00022	0.00001	0.00125		0.00551	0.00074	0.00058	0.00035
Jun-75	0.00078	0.01560	0.00696		0.00024	0.00009	0.00038	0.00017
Mar-75	0.00132	0.00022	0.00711		0.00008	0.00016	0.00014	0.00013
Dec-74	0.00192	0.00392	0.01466		0.00634			
Sep-74	0.00192	0.00230	0.01255		0.00130			
Jun-74	0.01206	0.00422	0.01275		0.00316			
Mar-74	0.00060	0.00037	0.00600		0.01708			
Dec-73	0.00007	0.00002	0.01381		0.00330			
Sep-73	0.00652	0.00194	0.01480		0.00680			
Jun-73	0.00108	0.00205	0.00039		0.02044			

	Crude Oil	Copper	Coal	Aluminum	Wheat	Corn	Rice	Sugar
Mar-11	0.33467	0.00047	0.00062	0.00055	0.00236	0.00298	0.00059	0.00552
Dec-10	0.00754	0.00047	0.00062	0.00055	0.00236	0.00298	0.00059	0.00552
Sep-10	0.00274	0.00281	0.00939	0.00005	0.00494	0.00109	0.00009	0.00093
Jun-10	0.00041	0.00457	0.00125	0.00197	0.02634	0.01416	0.00260	0.01821
Mar-10	0.00482	0.00815	0.00013	0.00888	0.01027	0.00119	0.00218	0.00317
Dec-09	0.00106	0.00197	0.00027	0.00201	0.00074	0.00066	0.00279	0.01123
Sep-09	0.00067	0.00255	0.00616	0.00624	0.00089	0.00045	0.00157	0.00231
Jun-09	0.00315	0.00865	0.00207	0.00500	0.00662	0.00003	0.00156	0.01902
Mar-09	0.02281	0.00405	0.00412	0.00297	0.00257	0.00129	0.00120	0.01079
Dec-08	0.00161	0.00644	0.01886	0.00121	0.00101	0.00108	0.00023	0.00179
Sep-08	0.07990	0.05399	0.02495	0.02873	0.00145	0.00588	0.00457	0.00052
Jun-08	0.02288	0.00873	0.00904	0.00956	0.00365	0.00582	0.00294	0.00089
Mar-08	0.00863	0.00072	0.01872	0.00014	0.00236	0.00882	0.01159	0.00479
Dec-07	0.00373	0.00770	0.03222	0.01032	0.00808	0.00385	0.07662	0.00600
Sep-07	0.00341	0.01018	0.00955	0.00065	0.00498	0.00223	0.00358	0.00085
Jun-07	0.00240	0.00100	0.00022	0.00468	0.02798	0.00188	0.00001	0.00025
Mar-07	0.00106	0.00026	0.00305	0.00074	0.00538	0.00148	0.00008	0.00075
Dec-06	0.00458	0.00545	0.00151	0.00021	0.00011	0.00132	0.00044	0.00064
Sep-06	0.00141	0.00336	0.00385	0.00100	0.00040	0.00574	0.00028	0.00010
Jun-06	0.00819	0.00005	0.00330	0.00010	0.00102	0.00077	0.00000	0.01891
Mar-06	0.00015	0.01310	0.00002	0.00473	0.00180	0.00016	0.00014	0.00294
Dec-05	0.00089	0.00150	0.00513	0.00022	0.00134	0.00041	0.00062	0.00296
Sep-05	0.00070	0.00369	0.00396	0.00589	0.00042	0.00128	0.00067	0.01066
Jun-05	0.00320	0.00113	0.00357	0.00059	0.00284	0.00207	0.00024	0.00394
Mar-05	0.00300	0.00181	0.00001	0.00252	0.00015	0.00014	0.00044	0.00115
Dec-04	0.00996	0.00106	0.00098	0.00166	0.00009	0.00088	0.00013	0.00069
Sep-04	0.01360	0.00055	0.00195	0.00010	0.00044	0.00016	0.00228	0.00027
Jun-04	0.00452	0.00024	0.00269	0.00013	0.00139	0.00136	0.00077	0.00235
Mar-04	0.00418	0.00210	0.00312	0.00100	0.00146	0.00158	0.00038	0.00433
Dec-03	0.00254	0.01136	0.01752	0.00055	0.00030	0.00301	0.00635	0.00285
Sep-03	0.00038	0.00451	0.01165	0.00071	0.00351	0.00131	0.00032	0.00038
Jun-03	0.00230	0.00048	0.00216	0.00020	0.00412	0.00078	0.00026	0.00157
Mar-03	0.00245	0.00090	0.00032	0.00090	0.00156	0.00015	0.00048	0.00412
Dec-02	0.00136	0.00011	0.00024	0.00026	0.00110	0.00002	0.00005	0.00123
Sep-02	0.00610	0.00142	0.00000	0.00073	0.00369	0.00015	0.00003	0.00114
Jun-02	0.00236	0.00167	0.00034	0.00033	0.01410	0.00463	0.00090	0.00318
Mar-02	0.00107	0.00044	0.00186	0.00009	0.00196	0.00113	0.00107	0.00186
Dec-01	0.01115	0.00101	0.00016	0.00020	0.00013	0.00014	0.00018	0.01949
Sep-01	0.00268	0.00113	0.00730	0.00067	0.00013	0.00115	0.00089	0.00376
Jun-01	0.00060	0.00115	0.00037	0.00069	0.00007	0.00031	0.00017	0.00771
Mar-01	0.00307	0.00055	0.00004	0.00057	0.00095	0.00067	0.00030	0.00306
Dec-00	0.00343	0.00016	0.00008	0.00139	0.00033	0.00032	0.00059	0.00511
Sep-00	0.01655	0.00072	0.00537	0.00102	0.00000	0.00419	0.00007	0.00227
Jun-00	0.00475	0.00186	0.00117	0.00053	0.00211	0.00141	0.00126	0.00251
Mar-00	0.01888	0.00092	0.00013	0.00033	0.00152	0.00524	0.00279	0.02817
Dec-99	0.00253	0.00086	0.00000	0.00123	0.00021	0.00018	0.00166	0.00235
Sep-99	0.00520	0.00018	0.00013	0.00099	0.00118	0.00013	0.00105	0.00377
Jun-99	0.00704	0.00135	0.00000	0.00106	0.00247	0.00047	0.00237	0.01274
Mar-99	0.00024	0.00091	0.00000	0.00034	0.00012	0.00006	0.00155	0.00292
Dec-98	0.00761	0.00037	0.00000	0.00031	0.00153	0.00023	0.00663	0.02258
Sep-98	0.01566	0.00152	0.00048	0.00050	0.00030	0.00014	0.00243	0.00201
Jun-98	0.00427	0.00013	0.00512	0.00018	0.00301	0.00784	0.00000	0.00890

	Crude Oil	Copper	Coal	Aluminum	Wheat	Corn	Rice	Sugar
Mar-98	0.00775	0.00172	0.00041	0.00169	0.00167	0.00065	0.00100	0.00817
Dec-97	0.00510	0.00064	0.00109	0.00026	0.00012	0.00001	0.00004	0.00618
Sep-97	0.00638	0.00575	0.00726	0.00071	0.00061	0.00081	0.00083	0.00165
Jun-97	0.00006	0.00583	0.00106	0.00150	0.00257	0.00089	0.00768	0.00026
Mar-97	0.00272	0.00197	0.00033	0.00050	0.01141	0.00261	0.00202	0.00018
Dec-96	0.01032	0.00002	0.00013	0.00037	0.00017	0.00144	0.00242	0.00046
Sep-96	0.00109	0.00579	0.00112	0.00350	0.00006	0.00308	0.00001	0.00043
Jun-96	0.00416	0.00044	0.00002	0.00054	0.00392	0.02454	0.00206	0.00129
Mar-96	0.00516	0.01112	0.00029	0.00152	0.00524	0.00145	0.00056	0.00121
Dec-95	0.00398	0.00014	0.00002	0.00009	0.00084	0.00191	0.00004	0.00023
Sep-95	0.00296	0.00089	0.00048	0.00003	0.00020	0.00068	0.00461	0.00040
Jun-95	0.00066	0.00084	0.00000	0.00139	0.00061	0.00029	0.00081	0.00579
Mar-95	0.00155	0.00141	0.00223	0.00065	0.00436	0.00229	0.00652	0.00038
Dec-94	0.00034	0.00052	0.00028	0.00461	0.00038	0.00021	0.00044	0.00018
Sep-94	0.00187	0.00620	0.00258	0.00356	0.00025	0.00156	0.00006	0.00488
Jun-94	0.00283	0.00038	0.00000	0.00150	0.00523	0.00017	0.00502	0.00116
Mar-94	0.00258	0.01283	0.00424	0.00227	0.00002	0.00016	0.01252	0.00203
Dec-93	0.00030	0.00081	0.00081	0.00262	0.00171	0.00072	0.02200	0.00437
Sep-93	0.00991	0.00086	0.00000	0.00073	0.00596	0.00472	0.01458	0.00048
Jun-93	0.00068	0.00064	0.00000	0.00141	0.00021	0.00006	0.00012	0.00032
Mar-93	0.00097	0.00173	0.00000	0.00070	0.00612	0.00182	0.00333	0.00413
Dec-92	0.00167	0.00064	0.00510	0.00072	0.00078	0.00042	0.00449	0.01997
Sep-92	0.00303	0.00052	0.00132	0.00040	0.00080	0.00004	0.00015	0.00117
Jun-92	0.00025	0.00056	0.00000	0.00032	0.00170	0.00070	0.00185	0.00260
Mar-92	0.00306	0.00042	0.00000	0.00028	0.00166	0.00003	0.00058	0.00236
Dec-91	0.00086	0.00036	0.00000	0.00197	0.00063	0.00099	0.00001	0.00133
Sep-91	0.00979	0.00165	0.00000	0.00058	0.00236	0.00022	0.00016	0.00085
Jun-91	0.00075	0.00047	0.00000	0.00116	0.00466	0.00044	0.00072	0.00291
Mar-91	0.00107	0.00292	0.00000	0.00195	0.00006	0.00068	0.00016	0.00917
Dec-90	0.01368	0.00008	0.00021	0.00004	0.00129	0.00030	0.00119	0.00128
Sep-90	0.01457	0.00250	0.00000	0.01720	0.00007	0.00018	0.00098	0.00119
Jun-90	0.11469	0.00226	0.00000	0.01898	0.00220	0.00338	0.00006	0.00275
Mar-90	0.00246	0.00088	0.00132	0.00022	0.00655	0.00013	0.00173	0.00675
Dec-89	0.00527	0.00386	0.00000	0.00143	0.00126	0.00041	0.00174	0.00144
Sep-89	0.00050	0.00718	0.00000	0.00293	0.00001	0.00016	0.00458	0.00317
Jun-89	0.00043	0.00509	0.00000	0.00052	0.00011	0.00096	0.00206	0.00002
Mar-89	0.00387	0.01084	0.00000	0.00687	0.00054	0.00029	0.00372	0.00070
Dec-88	0.00370	0.00211	0.00000	0.00560	0.00033	0.00003	0.00058	0.00645
Sep-88	0.01211	0.00768	0.00018	0.00099	0.00022	0.00113	0.00073	0.00192
Jun-88	0.00421	0.00331	0.00025	0.00382	0.00135	0.00109	0.00009	0.02880
Mar-88	0.00114	0.00284	0.00260	0.03136	0.00892	0.03024	0.00332	0.01346
Dec-87	0.00458	0.00564	0.00133	0.01500	0.00067	0.00056	0.00065	0.00607
Sep-87	0.00162	0.03427	0.00476	0.00600	0.00247	0.00076	0.00073	0.01247
Jun-87	0.00142	0.00111	0.00000	0.00205	0.00122	0.00127	0.02079	0.00170
Mar-87	0.00012	0.00085	0.00000	0.00075	0.00206	0.00202	0.00006	0.00050
Dec-86	0.00100	0.00192	0.00000	0.00610	0.00078	0.00127	0.00454	0.00661
Sep-86	0.00421	0.00012	0.00082	0.00024	0.00017	0.00138	0.00064	0.00244
Jun-86	0.04061	0.00029	0.00000	0.00163	0.00009	0.01337	0.00133	0.00931
Mar-86	0.00754	0.00005	0.00000	0.00010	0.01264	0.00040	0.00010	0.01853
Dec-85	0.05536	0.00020	0.00280	0.00067	0.00033	0.00092	0.00278	0.03723
Sep-85	0.00310	0.00007	0.00000	0.00220	0.00130	0.00311	0.00162	0.00206
Jun-85	0.00028	0.00145	0.00000	0.00030	0.00049	0.00391	0.00000	0.05366

	Crude Oil	Copper	Coal	Aluminum	Wheat	Corn	Rice	Sugar
Mar-85	0.00094	0.00112	0.00000	0.00160	0.00131	0.00031	0.00001	0.01422
Dec-84	0.00068	0.00017	0.00000	0.00012	0.00019	0.00001	0.00014	0.00090
Sep-84	0.00027	0.00080	0.00093	0.00338	0.00014	0.00101	0.00358	0.01869
Jun-84	0.00007	0.00032	0.00000	0.00530	0.00074	0.00206	0.00199	0.00406
Mar-84	0.00029	0.00352	0.00230	0.00154	0.00057	0.00005	0.00005	0.00200
Dec-83	0.00008	0.00193	0.00000	0.00098	0.00012	0.00103	0.00008	0.00167
Sep-83	0.00021	0.00027	0.00739	0.00027	0.00004	0.00034	0.00092	0.01420
Jun-83	0.00017	0.00193	0.00000	0.00106	0.00092	0.00174	0.00475	0.00401
Mar-83	0.00010	0.00073	0.00000	0.00152	0.00234	0.00004	0.00064	0.05241
Dec-82	0.00210	0.00057	0.00000	0.00916	0.00003	0.00525	0.00166	0.00104
Sep-82	0.00240	0.00011	0.01248	0.00035	0.00189	0.00602	0.00056	0.00229
Jun-82	0.00044	0.00009	0.00000	0.00000	0.00001	0.00479	0.00146	0.02241
Mar-82	0.00096	0.00737	0.00000	0.00170	0.00209	0.00005	0.00120	0.02812
Dec-81	0.01060	0.00118	0.00000	0.00160	0.00017	0.00005	0.00105	0.00653
Sep-81	0.00007	0.00002	0.00019	0.00079	0.00087	0.00086	0.00839	0.00209
Jun-81	0.00017	0.00103	0.00020	0.00082	0.00010	0.00755	0.00135	0.02804
Mar-81	0.00313	0.00126	0.00020	0.00277	0.00124	0.00087	0.00041	0.00701
Dec-80	0.00071	0.00045	0.00020	0.00006	0.00156	0.00136	0.00138	0.01505
Sep-80	0.00151	0.00199	0.00020	0.00422	0.00110	0.00052	0.00101	0.02968
Jun-80	0.00419	0.00087	0.00020	0.00154	0.00111	0.00235	0.00000	0.01267
Mar-80	0.00005	0.00038	0.00019	0.00547	0.00025	0.00056	0.00072	0.04032

Price Correlations 1981-1990

	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Aluminum	Wheat	Maize (Corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	0.938	1.000													
^FTSE	0.985	0.933	1.000												
Gold	0.183	0.147	0.130	1.000											
Crude Oil	-0.723	-0.752	-0.761	-0.150	1.000										
Copper	0.675	0.765	0.609	0.134	-0.373	1.000									
Coal	-0.456	-0.363	-0.540	0.028	0.611	0.028	1.000								
Aluminum	0.533	0.634	0.497	0.285	-0.466	0.730	-0.202	1.000							
Wheat	-0.381	-0.148	-0.426	-0.181	0.411	0.171	0.602	0.050	1.000						
Maize	-0.435	-0.339	-0.478	-0.282	0.477	-0.038	0.254	0.029	0.674	1.000					
Rice	-0.329	-0.230	-0.427	0.210	0.512	0.136	0.665	0.030	0.653	0.444	1.000				
Sugar	0.215	0.283	0.093	0.241	0.101	0.541	0.469	0.334	0.503	0.273	0.743	1.000			
USDEUR	-0.580	-0.552	-0.484	-0.559	0.305	-0.649	-0.197	-0.505	0.094	0.386	-0.262	-0.623	1.000		
USDGBP	-0.174	-0.184	-0.058	-0.562	-0.080	-0.499	-0.519	-0.384	-0.171	0.088	-0.567	-0.716	0.867	1.000	
USDCHF	-0.746	-0.700	-0.677	-0.478	0.522	-0.692	0.072	-0.603	0.283	0.490	0.022	-0.437	0.943	0.705	1.000

Price Correlations 1991-2000

	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Aluminum	Wheat	Maize (Corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	-0.464	1.000													
^FTSE	0.992	-0.491	1.000												
Gold	-0.850	0.496	-0.843	1.000											
Crude Oil	0.315	0.126	0.250	-0.238	1.000										
Copper	-0.587	0.297	-0.621	0.707	0.034	1.000									
Coal	-0.730	0.440	-0.763	0.674	-0.094	0.784	1.000								
Aluminum	0.238	-0.091	0.205	0.082	0.290	0.570	0.189	1.000							
Wheat	-0.433	0.248	-0.451	0.657	-0.127	0.622	0.680	0.311	1.000						
Maize	-0.301	0.372	-0.316	0.565	-0.149	0.394	0.572	0.222	0.879	1.000					
Rice	-0.250	0.191	-0.246	0.405	-0.426	0.394	0.539	0.216	0.636	0.690	1.000				
Sugar	-0.512	0.100	-0.512	0.707	-0.144	0.733	0.600	0.491	0.684	0.535	0.334	1.000			
USDEUR	0.816	-0.351	0.817	-0.769	0.457	-0.609	-0.766	0.081	-0.594	-0.481	-0.570	-0.480	1.000		
USDGBP	0.189	-0.157	0.214	0.099	0.190	-0.064	-0.355	0.187	0.110	0.083	-0.287	0.240	0.416	1.000	
USDCHF	0.533	-0.147	0.530	-0.704	0.439	-0.639	-0.644	-0.271	-0.703	-0.608	-0.666	-0.637	0.854	0.171	1.000

Price Correlations 2001-2011

	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Alumi num	Wheat	Maize (Corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	0.767	1.000													
^FTSE	0.895	0.787	1.000												
Gold	0.311	-0.091	0.351	1.000											
Crude Oil	0.595	0.282	0.563	0.769	1.000										
Copper	0.693	0.397	0.685	0.815	0.923	1.000									
Coal	0.422	0.014	0.353	0.776	0.909	0.795	1.000								
Aluminum	0.820	0.667	0.771	0.504	0.840	0.885	0.666	1.000							
Wheat	0.525	0.183	0.418	0.650	0.833	0.763	0.796	0.685	1.000						
Maize	0.411	0.005	0.338	0.791	0.871	0.800	0.912	0.657	0.862	1.000					
Rice	0.181	-0.097	0.194	0.785	0.813	0.717	0.891	0.536	0.729	0.836	1.000				
Sugar	0.237	-0.053	0.370	0.877	0.667	0.742	0.626	0.466	0.454	0.628	0.662	1.000			
USDEUR	-0.446	-0.211	-0.276	-0.668	-0.767	-0.756	-0.699	-0.681	-0.673	-0.663	-0.726	-0.523	1.000		
USDGBP	-0.653	-0.644	-0.399	-0.002	-0.453	-0.441	-0.259	-0.675	-0.420	-0.230	-0.129	0.063	0.648	1.000	
USDCHF	-0.352	-0.013	-0.210	-0.811	-0.785	-0.783	-0.757	-0.614	-0.669	-0.740	-0.770	-0.682	0.953	0.463	1.000

Volatility Correlations 1981-1990

	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Alumi num	Wheat	Maize (corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	0.707	1.000													
^FTSE	0.672	0.421	1.000												
Gold	-0.135	-0.023	-0.234	1.000											
Crude Oil	-0.024	0.022	-0.144	0.069	1.000										
Copper	-0.053	-0.047	0.002	-0.117	-0.065	1.000									
Coal	0.003	-0.016	-0.016	0.575	-0.110	0.158	1.000								
Aluminum	0.226	0.310	-0.034	-0.097	0.238	0.139	-0.004	1.000							
Wheat	0.044	0.053	-0.054	0.014	0.214	0.009	0.073	0.271	1.000						
Maize	0.121	-0.042	0.000	0.072	-0.081	-0.093	0.152	0.594	0.351	1.000					
Rice	-0.125	-0.104	-0.005	-0.101	-0.122	-0.053	-0.107	-0.007	-0.046	0.022	1.000				
Sugar	0.091	-0.098	0.106	0.042	-0.086	-0.042	-0.014	-0.132	0.111	0.071	-0.171	1.000			
USDEUR	0.013	-0.091	0.157	-0.052	0.074	-0.079	-0.113	-0.053	0.001	-0.101	-0.160	0.083	1.000		
USDGBP	-0.019	-0.097	0.140	-0.096	-0.018	0.008	-0.167	0.158	-0.098	-0.001	-0.155	0.086	0.676	1.000	
USDCHF	0.018	-0.003	-0.186	-0.048	0.268	-0.089	-0.186	0.265	0.068	-0.100	-0.150	-0.059	0.649	0.548	1.000

Volatility Correlations 1991-2000															
	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Aluminum	Wheat	Maize (corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	0.448	1.000													
^FTSE	0.716	0.473	1.000												
Gold	0.192	0.031	0.134	1.000											
Crude Oil	0.281	-0.016	0.296	-0.048	1.000										
Copper	-0.135	-0.164	-0.152	-0.190	-0.158	1.000									
Coal	0.284	0.173	0.189	-0.135	-0.135	0.328	1.000								
Aluminum	-0.073	-0.084	-0.100	-0.105	-0.005	0.378	0.011	1.000							
Wheat	0.024	0.143	0.003	-0.055	-0.010	0.014	-0.182	-0.204	1.000						
Maize	0.187	0.143	0.110	-0.040	0.018	-0.091	0.050	-0.142	0.243	1.000					
Rice	-0.055	0.148	0.313	0.091	-0.017	0.153	0.036	0.104	0.175	-0.011	1.000				
Sugar	0.000	0.018	-0.054	0.097	0.221	-0.155	0.079	-0.164	-0.128	0.003	0.039	1.000			
USDEUR	-0.111	0.161	-0.122	0.008	0.325	-0.243	0.095	-0.097	-0.040	-0.147	-0.068	0.117	1.000		
USDGBP	-0.221	0.041	-0.211	-0.076	0.094	-0.218	0.168	-0.173	-0.057	-0.135	-0.212	0.201	0.617	1.000	
USDCHF	-0.182	0.297	-0.135	0.007	0.099	-0.224	0.027	-0.108	0.013	-0.107	0.044	0.063	0.797	0.564	1.000

Volatility Correlations 2001-2011															
	^DJI	^N225	^FTSE	Gold	Crude Oil	Copper	Coal	Aluminum	Wheat	Maize (corn)	Rice	Sugar	USDEUR	USDGBP	USDCHF
^DJI	1.000														
^N225	0.346	1.000													
^FTSE	0.695	0.497	1.000												
Gold	-0.026	-0.219	-0.183	1.000											
Crude Oil	0.197	-0.129	0.124	0.148	1.000										
Copper	-0.027	-0.021	-0.001	0.532	0.251	1.000									
Coal	0.059	-0.079	-0.075	0.456	0.334	0.534	1.000								
Aluminum	-0.016	0.158	0.111	0.422	0.178	0.883	0.497	1.000							
Wheat	0.128	-0.065	0.186	-0.094	-0.098	-0.021	-0.073	0.093	1.000						
Maize	0.147	-0.055	0.159	0.196	0.005	0.253	0.325	0.235	0.498	1.000					
Rice	-0.044	0.001	-0.054	0.087	-0.041	0.116	0.664	0.283	0.112	0.197	1.000				
Sugar	0.018	0.090	0.064	0.222	-0.059	-0.107	-0.156	-0.063	0.143	0.146	0.039	1.000			
USDEUR	0.254	-0.162	0.111	0.390	0.220	0.429	0.202	0.338	0.316	0.563	-0.017	0.184	1.000		
USDGBP	0.186	-0.129	0.125	0.363	0.852	0.458	0.334	0.368	-0.008	0.027	-0.047	0.140	0.485	1.000	
USDCHF	0.337	-0.225	0.148	0.376	0.143	0.289	0.377	0.226	0.103	0.465	0.103	0.097	0.768	0.362	1.000

Zusammenfassung und Schlussfolgerungen

Trotz des theoretisch klingenden Titels ist meine Diplomarbeit stark Praxis orientiert. Die Titel ‚On the Variety of Opinion About What Is Uncertain' oder in Übersetzung ‚Über die Vielfalt der Meinungen über das Unsichere' bezieht sich meistens auf die Theorie hinter das praktische. Ich versuche durch ein neues Rahmenwerk das Thema Unsicherheit und Risiko, wie diese die Dynamik der Märkte einflusst, zu betrachten. In diese Rahmenbedingung die Verschiedenheiten in der Bearbeitung der verfügbaren Daten von den unterschiedlichen Marktteilnehmer tragen ein wichtiges Teil zum gesamten Marktrisiko bei. Diese Meinungsverschiedenheiten werden durch Marktvolatilität, als ein Proxy, quantifiziert.
Im empirischen Teil zwei verschiedene Punkte sind behandelt.
Zuerst wird Marktvolatilität verschiedenster Märkte – Aktien- und Gütermärkte sowie Währungen – betrachtet. In diesem Teil suche ich politische sowie ökonomische Gründe für Perioden erhöhter Volatilität. Perioden wie das Börsenkrach von 1987 oder das Dot Com Blase, wo die Entstehung nicht auf oben genannte Ereignisse zurückgeführt werden kann, sind von besondere Interesse. Ich finde dass Verhalten der Märkte oft durch neoklassiche Theorie *nicht* gut erklärt wird. Es gibt Perioden in dem die sogenannten Fundamentals kein dominierendes Einfluss ausüben. In diese Perioden Marktstimmung und Spekulation treiben die Märkte weit von den Fundamentals.
Im zweiten - wichtigeren - empirischen Teil werden Korrelationen der verschiedene Märkte über das lange Frist behandelt. Da bis dato keine systematische Behandlung der Marktkorrelationen, über eine solche Breite wie in dieser Diplomarbeit, versucht würde, sind meine Ergebnisse von großer praktischer Bedeutung.
Preis- *und* Volatilitätkorrelationen werden gerechnet. Diese Kennzahlen geben verschiedene Einblicke zum Marktmechanismus. Preiskorrelationen betonen insbesonders langfristige Trends. Volatilitätkorrelationen zeigen wie stark und wie schnell Preisschocks von einem Markt zum anderen übertragen werden. Die Kurzzusammenfassung, ohne Vertiefung in die Einzelheiten der verschiedene Korrelationen, meiner Ergebnisse ist folgendes. Die Korrelationen der verschiedene Assetgruppen – Aktien, Güter und Währungen – hat sich in der langen Frist signifikant verändert. In meine Analyse habe ich mich auf die verschiedene Jahrzehnte konzentriert. Zwischen 1980 und 2000 Schwanken die Korrelationen, aber ohne ein aussagekräftiges Trend. In das letzte Jahrzehnt aber das Trend ist sehr aussagekräftig und nämlich: die sechszehn Märkte sind viel stärker korreliert als in der Vergangenheit.
Das hat weit greifende Auswirkungen. Das ist eine neue ökonomische Realität. Das bedeutet dass Diversifizierung in verschiedene Märkte das Risiko einer Investition weniger minimiert und damit werden gleich große erwartete Renditen als in der Vergangenheit mit mehr Risiko verbunden.
Globalisierung und freie Kapitalströme haben die Gesamtheit der Märkte nicht mehr sondern weniger sicher gemacht. Individuelle Entscheidungen der

Regierungen z.B. in Monetär- und Handelspolitik ist somit schwieriger. Durch das erhöhte Korrelation werden Krisen stärker und schneller übertragen.
Fazit: Wegen grenzüberschreitende Kopplungen der modernen Weltwirtschaft ist das ganze System viel mehr ineinandergreifend geworden und Krisen werden wegen immer stärker werdende feedback loops akuter. Die Zukunft verspricht höhere Marktvolatilitäten.

Abstract

The chief aim of this paper is to serve as a systematic analysis of price volatilities of various assets and markets – stock and commodities as well as foreign exchange markets – over the long run. The analysis goes back as far as 1973 but most of the available datasets start in 1980. Concentrating on decade-wise calculations I have first searched for periods of high volatilities and attempted to explain them through either economic or political events. Especially the stock market crash of 1987 and the Dot Com Bubble are shining examples of instances where the aforementioned factors fail to explain the evolution of the markets. In these cases it is mostly market sentiment and other psychological reasons that drive the markets. In other instances it is very likely that speculation is being undertaken to the extent where it becomes the dominant driving force.
The most important part of this thesis is the analysis of price and volatility correlations. My findings are that in the 1980's and 1990's markets are on the whole quite uncorrelated. The last decade however, shows a marked departure from the past, both kinds of correlations greatly increase. This is proof of a new economic reality where markets move more in unison than ever before. Minimizing risk of financial investments by diversifying over various markets is fraught with more difficulty than before and makes investments with same expected returns as in the past riskier. This new economic reality has far-reaching consequences.
It is proof that markets, through globalisation, have become more interdependent. This interdependence makes implementation of efficient independent policies - especially monetary - by the various governments a much more difficult task. As volatility correlations have increased as well, price shocks are transmitted more strongly and promptly. This makes contagion more likely. The ongoing Great Recession serves as an outstanding example of my findings. Given these results, we should expect more volatile markets in the future.

Curriculum Vitae (academic, short version)

Born in Oradea, Romania I have graduated from high school there, bilingual specialization: English and Italian. Since Spring 2005 I have been working towards my degree in Economics (Diploma) at the University of Vienna. The main focus of my studies is economic theory, applied economics, and econometrics. Macroeconomics and finance have commanded my special attention and in case of further studies I wish continue in these fields.

Lebenslauf (Akademisch, gekürzte Version)

Geboren in Oradea, Rumänien habe die Matura dort erworben; Spezialisierung Englisch und Italienisch. Seit Frühjahr 2005 studiere ich Volkswirtschaft (Diplomstudium) an der Universität Wien. Im Focus meiner Studium steht ökonomische Theorie, angewandte Ökonomie und Ökonometrie. Makroökonomie und Finanzen sind für mich von besondere Interesse und im Falle einer Weiterbildung werde ich diese Gebiete fortsetzen.